MEMOIRS of the NATIONAL MUSEUM of VICTORIA

NUMBER
35

Melbourne Australia

18 February, 1974

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MEMOIRS

of the

NATIONAL MUSEUM OF VICTORIA

MELBOURNE AUSTRALIA

No. 35

CONTENTS

PORT PHILLIP SURVEY 1957-63
FORAMINIFERIDA

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Abstract

Two hundred and seventy-eight species and subspecies of Foraminiferida are recorded from the sediments collected during the Port Phillip Survey, augmented by littoral material collected by the writer. The distribution of foraminiferids within and just outside Port Phillip is discussed. New taxa proposed include one new genus, *Pseudohelenina* and 36 new species and subspecies, as follows: *Reophax barwonensis, Haplophragmoides pusillus, Ammobaculites? barwonensis, Quinqueloculina poeyana victoriensis, Triloculina sabulosa, Scutuloris parri, Lagena bassensis, Lagena nepeanensis, Lagena lonsdalensis, Lagena portesaensis, Bolivinella pendens, Guttulina yabei attenuata, Laryngosigma australensis, Oolina guttaformis, Fissurina pseudoformosa, Fissurina crassiannulata, Fissurina furcata, Fissurina multipunctata, Euuvigerina compacta, Hopkinsina victoriensis, Discorbinella infrapapillata, Rugidia simplex, Valvulineria minutissima, Valvulineria victoriensis, Elphidium granulosum, Elphidium vitreum, Elphidium articulatum multicameratum, Elphidium earlandi avalonense, Elphidium gunteri corioense, Rosalina parri, Planulina bassensis, Cibicides phillipensis, Cibicides wattsi, Cassidulina victorensis, Nonionella vortex, Trichohyalus australis.* Page references to the above are given in the Distribution Lists.

Acknowledgements

Introduction

The material received for study consisted of a large number of small samples of material which had been washed, graded and used in a study of the bottom sediments of Port Phillip (Beasley 1966). Full details of depths and the nature of sediments are given in the reference cited.

For the purposes of the Survey Port Phillip was subdivided into 70 Areas (Fig. 1), some of which were wholly or mostly on land. Material was not available for some of the marine Areas (14-15, 24, 34, 52, 65, 70). Fortunately, most of these are on the fringe of the Survey and not critical in respect of distribution. Areas 34 and 52 are located in the middle of the Bay, where the foraminiferal fauna is scanty and there is little variation between Areas. In the remainder of the marine Areas, from 1-4 station samples were available for study.

To these original samples were added shore collections made by the writer at nine stations inside and outside Port Phillip. These are listed in Table 1, with sufficient detail to enable location on Fig. 1. These collections were of value because they were generally more productive of species than the dredgings in adjoining Areas, and provided evidence of the distribution of shallow-water species which were rare in or absent from the deeper water samples. For example, the common Bass Strait species *Discorbis dimidiatus* occurred only occasionally in the dredgings from the inner Areas of Port Phillip, but was abundant in material collected from the sandy beach at Altona near the N. end of the Bay.

One of the shore stations, the sandy beach on the right bank of the Barwon River near its mouth at Barwon Heads (Area 56) is notable for the rich assemblage found there, presumably deposited by some unusual combination of wave and current action. This is the only Holocene locality in Victoria to have had a thorough taxonomic study made (Parr 1945), when 142 species were recorded, and it has provided many of the new species and records made in the present work. Another station

1

MELBOURNE

Kororoit Creek

Maribyrnong River

Williamstown

Yarra River

St. Kilda

Altona C1

Pt. Ormond

Brighton

Pt. Cook

Sandringham

Rickett's Pt.

Little River

Werribee River

Mordialloc

Kirk's Pt C2

Pt. Wilson

Carrum

Avalon C3

CORIO BAY

Geelong Outer Harbour

Portarlington

Indented Head

St. Leonards

C4

GEELONG

Pt. Henry

Curlewis

BELLARINE PENINSULA

Barwon River

Frankston

Mt. Eliza

Mornington

Swan Bay

Martha Cliff

Mt. Martha

Barwon Heads

Pt. Lonsdale

Dromana

Arthur's Seat

Rosebud

Rye

NEPEAN PENINSULA

MORNINGTON PENINSULA

101m. (183m)

101m. (183m)

N

Km

0   10
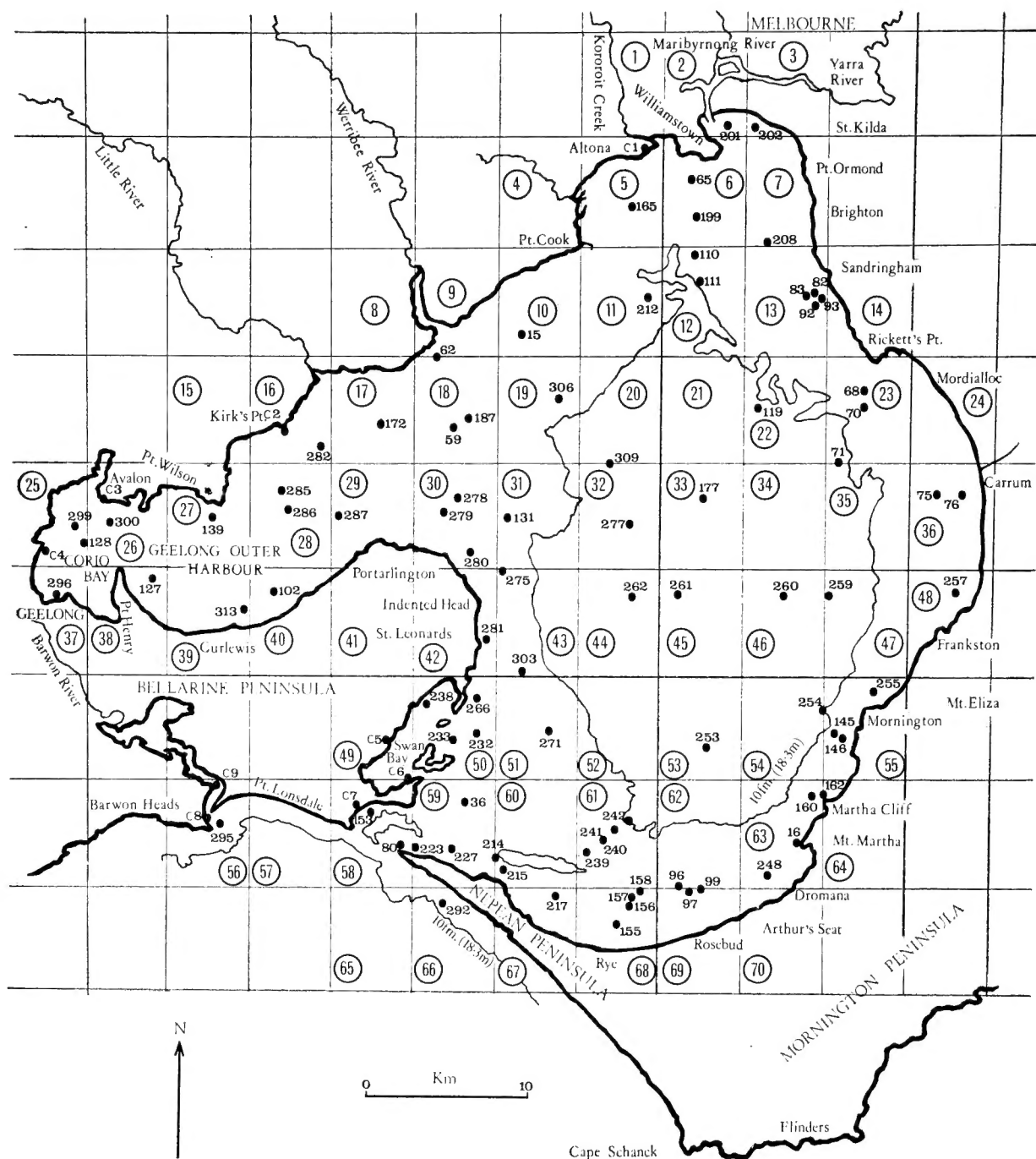
Flinders

Cape Schanck

FIGURE 1

further up the Barwon River near the N. edge of Area 56 was interesting in illustrating the discontinuous distribution of species otherwise confined to the shallow muddy shores of Swan Bay and the W. littoral of Port Phillip.

As the bulk of the material studied consisted of dried and sifted sediments, no indication was given of the actual living population, and the present work must be considered only as a faunal inventory, to be refined and confirmed or otherwise by future studies of material collected in the living state and appropriately preserved.

The distribution of Foraminiferida in the Survey is listed by Area numbers in the Systematic Account in respect of each taxon dealt with. In the case of holotypes, the station number is recorded in addition. Distribution sheets showing records by Area and Station numbers have been prepared for holding at the Museum in the form of transparencies from which prints can be made available to any workers requiring more detailed information. All station slides and single slides of holotypes and figured specimens are deposited with the National Museum of Victoria. Holotypes and figured specimens are identified in the text by Museum Registration numbers. The classification used is that of Loeblich and Tappan

TABLE 1

Location of Shore Collections

Area	Station Number	Location
5	CI	Beach sand, Altona Bay
16	C2	Beach sand, Kirk Point
26	C3	Beach sand, Avalon Beach, Corio Bay, N. of dredge station 300
25	C4	Beach sand, North Shore, Corio Bay, W. of station 128
49	C5	Beach sand, NW. shore of Swan Bay, W. of station 237
49	C6	Beach sand, Swan Bay, SE. corner of Area 49
58	C7	Beach sand, Point Lonsdale, N. of station 153
56	C8	Beach sand, right bank of Barwon River near mouth
56	C9	Muddy sand, right bank of Barwon River on N. boundary of Area 56

(1964) with modifications arising from later work.

Previous Work

The earliest study of material referred to as from Melbourne, Australia, was that of Parker and Jones (1865), when some 32 species were listed or described, including some well-known local species such as *Discorbis dimidiatus* and *Annulopatellina annularis*. Parr (1932) has cast doubt on the provenance of this material, mainly on the grounds of the inclusion of what is now known as *Cribrobulimina mixta* Cushman (= *Valvulina mixta* Parker and Jones 1865, nom. nud.). The present writer concurs fully with this judgment. *C. mixta* has never since been recorded from Victorian shore sands, though it is very common on the South Australian coast and may eventually be found on the far W. coast of Victoria. It does occur in the Pleistocene interglacial deposits of Port Fairy, W. Victoria, together with a fauna giving evidence of warmer conditions than the present, but has evidently withdrawn from local waters following the onset of cooler conditions in the later Pleistocene and Holocene.

This point is made because authors continually cite Melbourne as the type locality of species described in Parker and Jones' 1865 paper. It is far more likely that this material was collected on the S. Australian coast and loosely attributed to 'near Melbourne'.

Subsequent authors such as Watts (1883) and Chapman (1902, 1909, 1915) were conservative in referring local forms to well-known N. Hemisphere species, though Chapman (1909) recognized one new species and three new varieties.

During 1930-1940, various studies of genera and particular species by Chapman, Chapman and Parr, Parr, and Parr and Collins contained references to local Holocene species, in particular Parr (1932) in which a number of new species and varieties were described from Victorian Holocene localities. The first really critical study of a Holocene Victorian fauna was that of Parr (1945) dealing with the rich thanatocoenose at the mouth of the Barwon River. This falls within the area of the Port

Phillip Survey, and material from this locality has produced many new and interesting records.

Studies of off-shore material such as the 'Challenger' station 162 off East Moncoeur Is., Bass Strait (Brady 1884), the 'Endeavour' stations at the E. end of Bass Strait (Chapman 1941), and the Tasmanian stations of the BANZAR Expedition (Parr 1950) also have relevance to the fauna of the Lower Bay and the adjacent Bass Strait coastline.

The foraminiferal fauna of Port Phillip and the coasts of Bass Strait is now fairly well documented. What is now required is a detailed and quantitative study of the living populations and their ecology.

Fossil Admixtures

Any study of the Foraminiferida based on dead tests collected in or near Port Phillip must take into account the possible occurrence of reworked fossils derived from Tertiary or Quaternary sediments exposed as coastal sections and submarine outcrops. Many of these sediments consist of easily erodable clays, rich in foraminifers of continental shelf facies which are frequently unstained, uneroded, air-filled and practically indistinguishable from recently living specimens.

Dr Taylor (pers. comm.) has pointed out that many species now living in Victorian waters have a long range in local Tertiary formations. The presence of such species in Holocene material therefore requires care in interpretation.

In the inner Areas of Port Phillip recognition of Tertiary admixture is possible on ecological grounds. At station 127, Area 38 the existence of a submarine outcrop of Fyansford Clay in the sampling area is inferred from a mixed assemblage containing stillwater species characteristic of the general locality together with a shelf element which could be matched in the Miocene deposits of Curlewis, some 6 km to the E. Elsewhere in Port Phillip, no evidence of Tertiary admixture was found, suggesting that dispersal from known Tertiary exposures is very local.

On the Bass Strait coast, Tertiary cliff and submarine exposures occur at Ocean Grove,

less than 1 km E. of Station C8, Area 56 at Barwon Heads. Evidence of Tertiary admixture here is given by the presence of restricted Miocene species such as *Tubulogenerina ferox* (Heron-Allen and Earland). The rich thanatocoenose found at this station contains both the normal shallow water fauna of the Bass Strait coast and a strong shelf element, the latter presumably transported from deeper water by onshore currents. Long-ranging continental shelf species recorded from this station must therefore be subject to some doubt as to their provenance.

However, a check on the existence of such species in the living condition is afforded by the dredgings made in the vicinity of Port Phillip Heads, where downthrow of some hundreds of metres in Pleistocene time (Bowler 1966) precludes the possibility of submarine Tertiary exposure. The rich assemblages obtained from stations just within Port Phillip confirm the recent presence of species which, if recorded only from Barwon Heads, would be subject to some doubt.

A further source of admixture lies in the extensive areas of coastal and submarine outcrops of Pleistocene aeolianite on the Lower Bay and Bass Strait coasts. Foraminifers from this source tend to be leached and distinguishable from fresh specimens, and consist of the smaller and lighter forms found on the present Bass Strait beaches. Their presence, accordingly, is of little significance in view of the limitations of the material studied.

There remains, however, the possibility of derivation from Last Interglacial deposits in the areas close to the entrance to Port Phillip, which could account for the presence of rare specimens of species having a general warm water distribution, Confirmation of the local existence of such species in the living state must await the collection and preservation of fresh material, but as this limitation applies to the present collections generally, it appears reasonable to include them in the records.

Distribution and Faunal Regions

Analysis of the distribution of foraminiferal taxa (species and subspecies) within the area

of the Survey has led to the recognition of two main faunal regions, as follows:

1. *Bass Strait and the Lower Bay*, including Areas 50 (part), 56, 58-62, 66-69, with a weak extension off Indented Head (42-43). No material was available from Area 57, but its position in Bass Strait includes it in this region.

Within this region 30 taxa, all comparatively rare, were found only in Bass Strait stations. 143 taxa were found in Bass Strait and the Lower Bay only, 56 were distributed throughout the Survey area, 13 were found only in the Lower Bay, and 17 were common to both the Lower Bay and the Inner Bay (definition below), a total fauna of 259 taxa.

The Bass Strait element of 143 taxa forms a major part of the total of 229 recorded for the Lower Bay. How far this is due to transport from Bass Strait by tidal currents is a matter for conjecture which can only be settled by studies of the living population. The comparative rarity of taxa found only in Bass Strait suggests that transport may well be a factor.

The dividing line between the Lower and Inner Bay regions, in terms of Areas, is sharply defined except off Indented Head, where Bass Strait influence appears to wane gradually along the coast. For example, the Lower Bay Areas 50 and 59-62 provide records of 137, 97, 97, 153 and 81 taxa respectively, whereas the immediately adjoining Areas to the N. and E., 51-54 and 63, provide only 11, (no sample), 6, 10 and 21 taxa respectively.

This is partly due to the fact that these Areas roughly correspond to the S. end of the 18-24 m central basin (Fig. 1), which as other authors have noted is comparatively barren of animal life. However, no Area of the Inner Bay produced as many as 50 taxa, and the Lower Bay is therefore outstanding in the variety of its foraminiferal fauna. The present evidence suggests that the Lower Bay as defined is the area of tidal intrusion of the oceanic water mass, bringing a typical Bass Strait benthic fauna with a small pelagic element.

2. *The Inner Bay*, comprising all Areas within Port Phillip other than those listed as in the Bass Strait-Lower Bay region, and including Swan Bay (Areas 49, part of 50), a shallow, land-locked body of water with a restricted entrance having a small foraminiferal fauna similar to that of the W. littoral of Port Phillip.

Ninety taxa were recorded for this region, of which 56 were of general distribution, 17 were found also in the Lower Bay, and 17 were restricted to the Inner Bay.

The central basin below the 18 m line was the least productive area, having a limited fauna of species of wide distribution, such as have elsewhere been found to persist in the least favourable conditions. In this case siltation may be the unfavourable factor. Areas to the N. and E. approaching the outlets of the Yarra and Werribee Rivers respectively are distinctly more productive than the central basin, so that salinity variation does not appear to be the inhibiting factor, while depth differences are minor. The commonest species in the central basin are *Ammonia aoteanus, Elphidium* spp., *Bulimina marginata, B. elongata* and *Haplophragmoides pusillus*, with *Ammonia* dominant in most Areas.

Beyond the central basin to the N., E. and W. coasts, *Elphidium* spp. are distinctly dominant in numbers, with large polymorphinids (*Guttulina regina* and *G. yabei attenuata*). There are minor areas of concentration of particular species, e.g. Areas 54 and 55 off Mornington where *Reophax scorpiurus* is dominant in a small assemblage, and Area 12 where *Haplophragmoides pusillus* is similarly dominant.

The shallow and muddy W. littoral has much in common with Swan Bay, such species as *Trochammina inflata* and *Ammotium australiensis* being particularly common and well-developed. Though not directly connected with Port Phillip, station C9 in the Barwon estuary on the N. Boundary of Area 56 shows similarity to Swan Bay and the W. littoral of Port Phillip, with the addition of a tide-transported element of Bass Strait origin. One species found here, *Ammobaculites? barwonensis,* did not occur elsewhere in the Survey material.

Distribution Lists
(asterisks denote proposed new taxa)

1. Bass Strait only:

Ammodiscus mestayeri
Annulopatellina annularis
Cassidulina sp. A.
Ceratobuliminoides bassensis
Delosina complexa
Ehrenbergina aff. glabra
Epistominella exigua
Fischerinella helix
Fissurina foraminata
F. orbignyana
Glandulina laevigata
Globulina gibba globosa
Lagena implicata
L. spiralis
L. victoriensis
*Laryngosigma australiensis (p. 26)
Oolina borealis
Planispirillina dimidiata
Planodiscorbis grossepunctatus
Planularia australis
Plectofrondicularia aff. californica
Quinqueloculina vulgaris
Reophax friabilis
Robertina tasmanica
Stomatorbina concentrica
Spiroloculina aequa
Triloculina bertheliniana
Trochammina appressa
Trochammina sp. A
Ungulatella pacifica

2. Bass Strait and the Lower Bay

Amphicoryine hirsuta
A. scalaris compacta
Angulodiscorbis pyramidalis
Anomalina tasmanica
Anomalinoides nonionoides
Astacolus bassensis
Astrononion australe
Baggina phillipinensis
Bolivina decussata
B. lobata
B. subtenuis
Bolivinella folium
*B. pendens (p. 24)
Bronnimannia haliotis
Buliminoides gracilis
B. madagascariensis
Cancris auriculus
Cassidulina delicata
C. laevigata
Cibicides sp. A
*C. phillipensis (p. 49)
*C. wattsi (p. 49)
Clavulina difformis
Dentalina mutsui
D. subemaciata
*Discorbinella infrapapillosa (p. 35)
Ehrenbergina aspinosa
Elphidium crispum
*E. vitreum (p. 43)

Euuvigerina bassensis
*E. compacta (p. 33ı)
Fijiella simplex
Fissurina contusa
*F. crassiannulata (p. 28)
F. fasciata
*F. furcata (p. 28)
F. lacunata
F. marginata
*F. multipunctata (p. 28)
F. pacifica
*F. pseudoformosa (p. 28)
F. quinqueannulata
Frondicularia compta villosa
Gaudryina convexa
Glabratella australiensis
G. patelliformis
G. pulvinata
Globigerina bulloides
Globigerinoides trilobus
G. ruber
Globocassidulina minuta
Globorotalia inflata
G. hirsuta
G. truncatulinoides
Gypsina vesicularis
Gyroidina soldanii
Heronallenia lingulata
H. translucens
Karreria maoria
*Lagena bassensis (p. 22)
L. chasteri
L. distoma-margaritifera
L. elongata
L. favosopunctata
L. flatulenta
L. flexa
L. gracilis
*L. lonsdalensis (p. 22)
*L. nepeanensis (p. 22)
*L. portseaensis (p. 23)
L. ramulosa
L. striatopunctata
Laryngosigma williamsoni
Lenticulina australis
Martinottiella primaeva
Miliolinella subrotunda
Missippina pacifica
Neoconorbina frustata
Orbulina universa
Oolina caudigera
*O. guttaformis (p. 27)
O. melo
O. pseudocatenulata
O. variata
Ophthalmidium circularis
Parrellina verriculata
Patellinella inconspicua
Pavonina triformis
Peneroplis planatus
Planispirillina denticulata
Planispirinoides bucculentus
Planodiscorbis rarescens
Planularia patens
*Planulina bassensis (p. 48)
Planulinoides biconcavus
P. disparilis

P. planoconcavus
Notorotalia clathrata
Pseudobulimina chapmani
*Pseudohelenina collinsi gen. nov. (p. 37)
Pullenia bulloides
P. quinqueloba
Pyrgo denticulata
Quinqueloculina anguina arenata
Q. baragwanathi
Q. bradyana
Q. moynensis
*Q. poeyana victoriensis (p. 16)
Rectobolivina dimorpha pacifica
Reussella armata
Rosalina anglica
R. australis
R. bertheloti
R. coronata
R. kennedyi
R. pustulata
R. williamsoni
*Rugidia simplex (p. 38)
*Scutuloris parri (p. 18)
Sigmoidella kagaensis
Sigmoilina australis
Sigmoilopsis sabulosa
Sigmomorphina undulosa
Siphonina tubulosa
Sphaeroidina bulloides
Spirillina inaequalis
S. vivipara
Spiroloculina angusteoralis
S. communis
S. disparilis
S. sublimbata
Spiroplectammina atrata
Textularia australis
T. kerimbaensis
T. pseudogramen
Torresina involuta
Tretomphalus concinnus
T. planus
Trifarina angulosa
T. bradyi
T. elliptica
*Triloculina sabulosa (p. 18)
T. striatotrigonula

3. Bass Strait, Lower Bay and Inner Bay

Acervulina inhaerens
Ammonia aoteanus
Astrononion novozealandicus
Bolivina compacta
B. pseudoplicata
B. robusta
B. subreticulata
Brizalina striatula
Bulimina marginata
Cassidulina carinata
*C. victoriensis (p. 52)
Cassidulinoides chapmani
Cibicides mayori
Clavulina multicamerata
Cyclogyra planorbis
Dentalina guttifera
Discorbis dimidiatus

Elphidium advenum
E. argenteum
*E. articulatum multicameratum (p. 43)
*E. gunteri corioensis (p. 44)
E. limbatum
E. macellum
E. sculpturatum
E. selseyense
E. simplex
Fissurina lucida
Florilus scapha
Fursenkoina schriebersiana
Globocassidulina subglobosa
Guttulina regina
G. silvestrii
Lagena crenata
L. perlucida
L. striata
L. sulcata
Lenticulina gibba
Miliolinella labiosa
Nubecularia lucifuga
Patellina corrugata
Planorbulina mediterranensis
Quinqueloculina lamarckiana
Q. poeyana
Q. seminulum
Q. subpolygona
Rectobolivina digitata
R. raphanus
*Rosalina parri (p. 46)
Spiroloculina antillarum
Svratkina australiensis
Triloculina oblonga
T. trigonula
Trochammina tasmanica
Turrispirillina depressa
Siphouvigerina canariensis
Vaginulina vertebralis

4. Lower Bay and Inner Bay

Ammotium australiensis
Bulimina echinata
B. elongata
*Elphidium earlandi avalonense (p. 43)
Florilus grateloupi
Guttulina pacifica
*G. yabei attenuata (p. 24)
*Haplophragmoides pusillus (p. 9)
*Hopkinsina victoriensis (p. 34)
Neoconorbina terquemi
Nonionella cf. *parri*
Reophax scorpiurus
Textularia tenuissima
Triloculina tricarinata
Trochammina bartrumi
T. ochracea
Vertebralina striata

5. Lower Bay only

Chrysalidinella dimorpha
Cibicides lobatulus
Dimorphina sp. A
Massilina ammophila
Neoconorbina tuberocapitata

Nodosaria perversa
Nonionella pulchella
*N. vortex (p. 54)
Oolina hexagona
Remaneica plicata
Saracenaria italica
S. latifrons
Spirillina pectinimarginata aspinosa

6. Inner Bay, Swan Bay and Upper Barwon

Ammobaculites exiguus
Ammonia tepida
Cassidulina inflata
Elphidium evolutum
*E. granulosum (p. 43)
Hopkinsina pacifica
Miliammina fusca
Nonion depressulus
Planorbulina sp. A
Reophax sp. A
*R. barwonensis (p. 8)
R. dentaliniformes
Spiroloculina lucida
*Trichohyalus australis (p. 55)
Trochammina inflata
*Valvulineria minutissima (p. 39)
*V. victoriensis (p. 39)

7. Upper Barwon only

*Ammobaculites? barwonensis (p. 9)

SYSTEMATIC ACCOUNT

Order FORAMINIFERIDA
Suborder TEXTULARIINA
Superfamily AMMODISCACEA
Family AMMODISCIDAE
Subfamily AMMODISCINAE
Genus AMMODISCUS Reuss, 1862

1. **Ammodiscus mestayeri** Cushman

Ammodiscus mestayeri Cushman, 1919, p. 597, pl. 74, figs. 1-2; Parr 1945, p. 193, pl. viii, figs. 1-2.

One specimen only, from Barwon Heads (56-C8).

Superfamily LITUOLACEA
Family HORMOSINIDAE
Subfamily HORMOSININAE
Genus REOPHAX Montfort, 1808

2. **Reophax scorpiurus** Montfort

Reophax scorpiuris Montfort, 1808, p. 330, 83° genre; Brady, 1884, p. 291, pl. xxi, figs. 12-17; Chapman 1909, p. 126; Parr 1932, p. 3, pl. 1, fig. 3; 1950, p. 268.

This cosmopolitan species is very common in Areas 54 and 55 off Mornington, with occasional specimens elsewhere, mainly in the E.

and central regions. Its comparative abundance in the Mornington area may be related to the greater availability of the angular quartz grains from which it constructs its test, derived from nearby granitic rocks.

Distribution: 12, 23, 30, 32-33, 36, 46, 54-55, 63, 68.

3. **Reophax friabilis** Parr

Reophax friabilis Parr, 1932, p. 3, text-fig. 1a, pl. 1, figs. 2a-b.

Three specimens from Barwon Heads (56-C8) agree with Parr's description. His specimens were from Point Lonsdale (58).

4. **Reophax** cf. **dentaliniformis** Brady

Reophax cf. *dentaliniformis* Brady, 1884, p. 293, pl. xxx, figs. 21-22.

One three-chambered specimen, 1·2 mm in length, from Corio Bay (37-296) has the arcuate form, elongate final chamber and produced aperture of Brady's species, which is worldwide in distribution. Previous records of this species are from deep water, which raises some doubt as to the identity of the present specimen from 3·7 m in a shallow land-locked bay.

5. **Reophax** sp. A

This is one of the *R. scotti* group, close to *R. catella* Höglund, which has a similar wall structure and chamber form but is about half the length with twice as many chambers. It is understood that this species is being described as new in a forthcoming work on the foraminiferida of Westernport, Vict., by Mr K. N. Bell, and it is therefore only recorded as occurring in Port Phillip, in the following Areas: 5, 26-28, 39, all in the W. Bay.

6. **Reophax barwonensis** sp. nov.
Pl. 1, fig. 1

Test straight or slightly curved, initial chamber bulbous and wider than the next following, later chambers 10-12 in number, broad and low with slightly depressed sutures and increasing slightly in width toward the distal end. Wall composed of sand grains of varying size, roughly finished. Aperture rounded, terminal, in a slight depression in the apertural face.

Holotype from 56-C9, Barwon River estuary, Reg. No. G2113. Length 0·57 mm, breadth 0·14 mm.

This small species is common at the type locality and was also found in Areas 5, 17, 26, 37 and 49, all of which are shallow muddy locations.

Family Rzehakinidae
Genus Miliammina Heron-Allen and Earland, 1930

7. **Miliammina fusca** (Brady)

Quinqueloculina fusca Brady, 1870, p. 286, pl. 11, figs. 2a-c.
Miliammina fusca (Brady). Parker and Athearn 1959, p. 340, pl. 50, figs. 11-12; Albani 1968, p. 95, pl. 7, figs. 1-2.

Very abundant in the Barwon estuary (56-C9). Specimens were similar to those figured by Albani from Port Hacking, N.S.W., in a somewhat similar environment. Other specimens occurred sparsely in the W. Bay, in Areas 5, 7, 18, 26-27, 31 and 38.

Family Lituolidae
Subfamily Haplophragmoidinae
Genus Haplophragmoides Cushman, 1910

8. **Haplophragmoides pusillus** sp. nov.
Pl. 1, figs. 2a-b

?*Haplophragmium canariense* (d'Orbigny). Chapman 1909, p. 126.

Test minute, planispiral, somewhat compressed, slightly evolute with depressed umbilicus, periphery rounded and lobulate. Chambers inflated with depressed sutures, six in the last whorl, increasing in both size and inflation. Aperture simple, arcuate, peripheral, with slight lip. Wall thin, composed of sand grains of varying size with minimal cement, surface slightly rough.
Holotype from 12-110, Reg. No. G2114. Max. diam. 0·35 mm, thickness 0·14 mm.

This species has points of resemblance to *Haplophragmoides canariense* (d'Orbigny) but is much smaller, averaging 0·27 mm in diameter and is rather more compressed, with fewer chambers to the whorl and more rapid increase in size of the later chambers. It is

probably Chapman's "small compressed form" of *H. canariense* recorded from Beaumaris, Port Phillip.

It has a wide but discontinuous distribution: N. Bay Areas 6, 12; W. Bay 16, 18, 26-28, 30; S.W. and Lower Bay 36, 54-55, 61-62, 68. It was very common in Areas 12 and 55, common in Area 28, otherwise rare to very rare. It was not found at any Bass Strait station.

Subfamily Lituolinae
Genus Ammobaculites Cushman, 1910

9. **Ammobaculites? barwonensis** sp. nov.
Pl. 1, figs. 3a-b

Test small, agglutinated, early portion spirally coiled and involute, with depressed umbilicus and slightly depressed sutures, consisting of about eight visible chambers. Later portion consists of up to five broad, low chambers, subcircular in section and added in a rectilinear series, with slightly depressed sutures. Distal end flat or slightly convex, with no definite aperture. Wall thin, composed of sand grains of varying size, surface rough, chambers simple, not labyrinthic.
Holotype from 56-C9, Barwon estuary. Reg. No. G2115. Length 0·43 mm, diameter of spiral portion 0·29 mm, thickness 0·21 mm.

This small species is referred with some doubt to *Ammobaculites*, because of the absence of a definite terminal aperture. It is possible that minute interspaces between grains on the distal face function as such. Found at the type locality only.

10. **Ammobaculites exiguus** Cushman and Bronniman

Ammobaculites exiguus Cushman and Bronniman, 1948, p. 38, pl. 7, figs. 7-8; Hedley, Hurdle and Burnett, 1967, p. 19, pl. 5, figs. 5a-b.

Common at Swan Bay (49) and occasionally found in littoral collections from the W. coast of Port Phillip. Described from shallow water in the West Indies, it is recorded from the *Corallina officinalis* zone on the New Zealand coast (Hedley et al.). Distribution: 5, 10, 26, 49.

Genus AMMOTIUM Loeblich and Tappan, 1953

11. **Ammotium australiensis** (Collins)

Ammomarginulina australiensis Collins, 1958, p. 351, pl. 1, figs. 10a-b (non *Ammomarginulina* Wiesner, 1931).

This species was described from the Great Barrier Reef and noted at the time as occurring in Corio Bay. Further consideration of its generic position suggests that it should be placed in *Ammotium*. In nearly all specimens the final chamber reaches back to the spiral portion of the test, and only very occasionally is a quasi-uniserial chamber added as figured by Collins (loc. cit.). It differs from *A. cassis* in the compression of the later part of the test, resulting in a slit-like rather than a rounded terminal aperture. Distribution: 17, 25-27, 39-40, 42, 49-50, 67. Common in Corio Bay and Swan Bay in shallow muddy conditions.

Figured specimen from 26-C3, Reg. No. G2116. Length 0·90 mm, breadth 0·50 mm, thickness 0·27 mm.

Family TEXTULARIIDAE
Subfamily SPIROPLECTAMMININAE
Genus SPIROPLECTAMMINA Cushman, 1927

12. **Spiroplectammina atrata** (Cushman)

Textularina sagittula Defrance, var. *atrata* Cushman, 1910 etc. (1911), p. 7, text-figs. 2-5; Albani 1968, p. 96, pl. 7, fig. 6.
T. sagittula Defrance. Chapman 1941, p. 192; Collins 1953, p. 97.

This compressed and comparatively sharp-edged form, with sutures usually outlined in dark material, is that which has generally been recorded in local studies as *T. sagittula* Defrance. The writer has examined a slide labelled as of this species and mounted by the late W. J. Parr from 'Endeavour' station 3918, from which it was recorded by Chapman (1941) with the following comments "This species is common on the Australian coast . . . In the previous material from the 'Endeavour' it was recorded as *Spiroplecta sagittula*."

Loeblich and Tappan (1964, p. C253) state that *T. sagittula* Defrance, the type species of the genus *Textularia* from the Pliocene of Italy, is a large (up to 3 mm) elongated textularian of approximately circular cross-section

and biserial throughout. Their definition of the genus and of the subfamily Textulariinae excludes other than biserial forms.

The present form is comparatively small (length 0·5-0·7 mm), compressed, sharp-edged and in the majority of specimens has an initial spiral stage of 3-4 chambers after the proloculus, as illustrated by Cushman (ibid.). In short, it bears no relationship to *T. sagittula* of Defrance as now understood, though in general form it resembles "*T. sagittula*" of Brady (1884) and later authors.

The writer agrees with Albani (1968) in referring it to Cushman's variety *atrata*, but considers that it cannot be regarded as a sub-species of *T. sagittula*, nor indeed as a *Textularia*. In the series from 'Endeavour' station 3918 referred to above, three specimens are sharp-ended and apparently biserial throughout. The remaining 14 specimens and most of those examined from the present material have a rounded aboral end and a spiral initial stage. It is therefore considered that Cushman's variety *atrata* should be given specific rank and transferred to the genus *Spiroplectammina* Cushman.

Distribution: 50, 56, 58, 60-62, 66, 68-69.

Subfamily TEXTULARIINAE
Genus TEXTULARIA Defrance, 1824

13. **Textularia pseudogramen** Chapman and Parr

Textularia pseudogramen Chapman and Parr 1937, p. 153; Parr 1945, p. 194; 1950, p. 275.

This common Bass Strait species is found also in the Lower Bay. Distribution: 50, 56, 58-62, 68-69.

14. **Textularia australis** Parr

Textularia australis Parr, 1950, p. 275, pl. iv, figs. 30a-c.

Described from off Albany, W. Aust., and noted by Parr as occurring at Raine Is. and on the E. Australian coast, this species is not uncommon in Lower Bay and Bass Strait stations. Distribution: 50, 56, 59, 61-62, 66-68.

15.   **Textularia kerimbaensis** Said

Textularia kerimbaensis Said, 1949, p. 6, pl. 1, fig. 8;
  Collins 1958, p. 353.

This species is widely distributed in the Indo-Pacific area. Local specimens tend to be rather more smoothly finished than tropical ones, but are otherwise conspecific. Restricted to Bass Strait and the Lower Bay.
Distribution: 50, 56, 58-62, 66-69.

16.   **Textularia tenuissima** Earland

Textularia tenuissima Earland, 1933, p. 95, pl. iii,
  figs. 21-30; Chapman and Parr 1937, p. 151, pl. x,
  fig. 43; Parr 1950, p. 92.

Specimens referable to this cosmopolitan species were present but rare at four stations on the W. and S. coasts of Port Phillip. They were compared with specimens in the Parr collection from the Antarctic and S.W. Ireland and are considered to be conspecific, though not reaching the same degree of development in length and in number of chambers.
Distribution: 5, 27, 40, 68.

Family TROCHAMMINIDAE
Subfamily TROCHAMMININAE
Genus TROCHAMMINA Parker and Jones, 1859

17.   **Trochammina inflata** (Montagu)

Nautilus inflatus Montagu, 1808, p. 81, pl. xviii, fig. 3.
Trochammina inflata (Montagu). Brady 1884, p. 338,
  pl. xli, fig. 4; Parr 1945, p. 194, pl. viii, figs. 4a-b;
  Albani 1968, p. 96, pl. 7, figs. 3-5.

Recorded by Parr from the mouth of the Barwon River (56-C8), it has not been found at this locality in the present collections, nor does it normally occur in clean sandy beach deposits. However, it is abundant on the mud-flats higher up the river (56-C9), together with other arenaceous species of brackish-water provenance, and is obviously tolerant of low salinities, as noted by both Parr and Albani.

In the present material it occurs in shore collections made on the muddy W. littoral of Port Phillip and in Swan Bay, the exception being a single specimen from a depth of 9 m E. of Point Henry (38). In none of these localities is there any appreciable freshwater influence, being coastal rather than estuarine.

The present evidence suggests that *T. inflata* is adapted for life in a shallow, muddy inshore environment, and is also tolerant of low salinity where a suitable substrate occurs. This agrees with Brady's observations (1884, p. 339) on its distribution around the English coast. Its habitat preference may relate to the availability of the silt-size particles with which it constructs its particularly fine-grained test.
Distribution: 5, 16, 26, 38, 49, 56.

18.   **Trochammina tasmanica** Parr

Trochammina tasmanica Parr, 1950, p. 279, pl. v,
  figs. 18a-c.

A few specimens were found in the Lower Bay and outside the Heads. The species was described from off Tasmania.
Distribution: 55-56, 66, 68.

19.   **Trochammina appressa** Parr

Trochammina appressa Parr, 1950, p. 277, pl. v,
  figs. 6-7a-b.

Three specimens of this small scale-like species were found at Barwon Heads (56-C8). It was described from off the E. coast of Tasmania.

20.   **Trochammina bartrumi** Hedley, Hurdle and Burnett

Trochammina bartrumi Hedley, Hurdle and Burnett,
  1967, p. 21, text-figs. 9-10, pl. 6, figs. 2a-c.

Specimens having a stellate umbilicus, sigmoid ventral sutures and interio-marginal extra-umbilical—umbilical aperture are referred to this species, described from the North Island of New Zealand.
Distribution: 16-17, 30-31, 61-62, 68.

21.   **Trochammina** sp. A
Pl. 1, figs. 5a-c

Reg. No. G2117. Two specimens from 56-C8 which did not appear to belong to any described species, and possibly not in this genus, are described and figured for the record, under open nomenclature.

Test trochospiral in the early stages, last chamber added on the opposite side of the test, with four chambers in the last whorl.

B

Dorsal side nearly flat, all chambers visible, sutures recurved and slightly depressed, periphery lobulate. Ventral side shows only the last whorl, with depressed umbilicus, ventricose chambers and radial depressed sutures. Aperture umbilical with small lip. Wall thin, rigid, pseudo-chitinous with a thin layer of fine sand grains and short lengths of sponge spicule.

This form may be compared with *T. alternans* Earland (1934, p. 103, p. iii, figs. 24-27) which however has fewer and more inflated chambers, takes on the alternating character earlier and is a deep-water species. The development of an alternating growth series would appear to justify separation of these two species from *Trochammina* s. str., but material at present available is insufficient for a full diagnosis.

22. Trochammina ochracea (Williamson)

Rotalina ochracea Williamson 1858, p. 55, pl. iv, fig. 112, pl. v, fig. 113.
Trochammina ochracea (Williamson). Balkwill and Millett 1884, p. 25, pl. 1, fig. 7; Heron-Allen and Earland 1932, p. 344.

Minute (0.3 mm diam.) depressed concavo-convex specimens having a pseudo-chitinous ventral wall with recurved and somewhat sigmoid raised sutures, which appear light-coloured in contrast with the dark brown of the chamber wall, are referred to this species, which is cosmopolitan in distribution. It occurs rarely at a few stations in the Inner and Lower Bay—Areas 13, 61 and 68.

Subfamily REMANEICINAE
Genus REMANEICA Rhumbler, 1938

23. Remaneica plicata (Terquem)

Patellina plicata Terquem, 1875 etc. (1876), p. 72, pl. viii, fig. 9.
Trochammina plicata of authors.
Remaneica plicata (Terquem). Rhumbler 1938.
R. aff. *plicata* (Terquem). Collins 1958, p. 354.

Three specimens from the Lower Bay and several from the Barwon estuary are referred to this species, in which the plications are much more developed than in the genotype *R. helgolandica*. The specimens from the Barrier Reef

listed by the writer (loc. cit.) are now considered to belong in this species.
Distribution: 56, 61-62.

Family ATAXOPHRAGMIDAE
Subfamily VERNEUILININAE
Genus GAUDRYINA d'Orbigny, 1839

24. Gaudryina convexa (Karrer)

Textilaria convexa Karrer, 1865, p. 78, pl. 16, figs. 8a-c.
Gaudryina convexa (Karrer). Burdett, Hedley, Hornibrook and Hurley 1963, p. 516 *et seq.*
Gaudryina hastata Parr 1932, p. 219, pl. 22, figs. 40a-b.
G. (Pseudogaudryina) hastata Parr 1945, p. 195.

Burdett et al. have shown that Parr's species falls within the limits of variation of *G. convexa*, which has a wide distribution in the S.W. Pacific. In the present collections it is confined to the Lower Bay and stations outside the Heads, where it is fairly common.
Distribution: 50, 56, 58-59, 61-62, 66, 68.

Subfamily VALVULININAE
Genus CLAVULINA d'Orbigny, 1826

25. Clavulina multicamerata Chapman

Clavulina parisiensis d'Orbigny var. *multicamerata* Chapman, 1909, p. 127, pl. lx, fig. 5.
C. multicamerata Chapman. Parr 1932, p. 4, pl. 1, figs. 4-5; 1945, p. 194.

The records of this species have all been from shallow water on the Victorian coast. It is fairly common in Lower Bay stations and occurs also on the W. littoral at Kirk Point and Avalon, and in Bass Strait stations.
Distribution: 16, 26, 50, 56, 58-62, 69.

26. Clavulina difformis Brady

Clavulina angularis d'Orbigny var. *difformis* Brady, 1884, p. 396, pl. xlviii, figs. 25-31.
Clavulina difformis Brady. Cushman 1924, p. 23, pl. vi, figs. 5-6; Parr 1932, p. 5, pl. 1, figs. 5-6.

This species is comparatively rare in Victorian waters, though common further W. in St. Vincent Gulf, S. Aust. Single specimens were found at two stations, 56-C8 and 62-96.

Genus MARTINOTTIELLA Cushman, 1933

27. **Martinottiella primaeva** (Cushman)

Clavulina primaeva Cushman 1910 etc. (1913), p. 635, pl. lxxx, figs. 4-5.
Schenkiella primaeva (Cushman). Parr, 1950, p. 283.
Martinottiella primaeva (Cushman). Loeblich and Tappan 1964, p. C282, fig. 188, 11.

This Pacific species was recorded by Parr from off Tasmania. Three specimens were found, only one developing a full uniserial stage.
Distribution: 61, 66, 68.

Suborder MILIOLINA
Superfamily MILIOLACEA
Family FISCHERINIDAE
Subfamily CYCLOGYRINAE
Genus CYCLOGYRA Woods, 1842

28. **Cyclogyra planorbis** (Schultze)

Cornuspira planorbis Schultze, 1854, p. 40, pl. 2, fig. 21.
Cyclogyra planorbis (Schultze). Loeblich and Tappan 1964, p. C438, fig. 392, 2.

A small (0·20-0·25 mm) semi-translucent *Cyclogyra* with rounded periphery, consisting of a proloculus and 3-5 whorls is referred to this species which was described from the Gulf of Mexico. It has a fairly general distribution in the Survey area, but is nowhere common. Similar specimens have been collected by the writer in beach sands from Noumea and the New Hebrides. Brady (1884, pl. xi, fig. 3 only) under the name of *Cornuspira involvens* Reuss has figured a very similar form which (Nuttall 1927) was derived from Kerguelen Is. *Cyclogyra involvens*, however, is a much larger species with many more whorls and a squarish periphery.

This species appears to have a wide distribution in the Pacific, which would probably be extended if older records of *C. involvens* were to be critically examined. The writer's record of *C. involvens* from the Great Barrier Reef probably refers to this species, as it was noted that specimens were small with 4-5 convolutions.
Distribution: 2, 5-6, 17, 26-28, 49-50, 56, 61-62, 66, 68.

Subfamily FISCHERININAE
Genus FISCHERINELLA Loeblich and Tappan, 1962

29. **Fischerinella helix** (Heron-Allen and Earland)

Fischerina helix Heron-Allen and Earland, 1914 etc. (1915), p. 591, pl. xlvi, figs. 10-14.
Fischerinella helix (Heron-Allen and Earland). Loeblich and Tappan, 1962, p. 108.

Four specimens were found at 56-C8 and one at 58-C7. This species was described from the coast of East Africa, and the writer has collected it from beach sand, Tanna, New Hebrides. In common with some other references herein, it may represent a relict tropical element still existing in the local fauna.

Family NUBECULARIIDAE
Subfamily NUBECULARIINAE
Genus NUBECULARIA Defrance, 1825

30. **Nubecularia lucifuga** Defrance

Nubecularia lucifuga Defrance, 1820 etc. (1825), p. 210, pl. xliv, fig. 3; Brady 1884, p. 134, pl. i, figs. 9-16; Parr 1945, p. 13.

A few specimens only. Except for one specimen from Avalon Beach (26-C3), all were from the Lower Bay or outside the Heads.
Distribution: 26, 49-50, 56, 58, 61.

Subfamily OPHTHALMIDIINAE
Genus OPHTHALMIDIUM Kübler and Zwingli, 1870

31. **Ophthalmidium circularis** (Chapman)

Spiroloculina dorsata Reuss var. *circularis* Chapman, 1915, p. 7, pl. 1, fig. 1.
Ophthalmidium circularis (Chapman). Chapman 1941, p. 186; Parr 1950, p. 286, pl. v, fig. 30.

This species occurs only in the Lower Bay and Bass Strait stations.
Distribution: 50, 56, 58, 61, 66, 68.

Subfamily SPIROLOCULININAE
Genus SPIROLOCULINA d'Orbigny, 1826

32. **Spiroloculina sublimbata** Parr

Spiroloculina sublimbata Parr, 1950, p. 291, pl. vi, figs. 14a-c.

Common in the Lower Bay and Bass Strait stations, but not found further N. in Port Phillip.
Distribution: 50, 56, 58-62, 68-69.

33. **Spiroloculina angusteoralis** Parr

Spiroloculina angusteoralis Parr, 1950, p. 292, pl. vi, figs. 15a-c.

Rare in the Survey collections, being found at only four stations in Bass Strait and the Lower Bay.

Distribution: 56, 58, 61, 68.

34. **Spiroloculina disparilis** Terquem

Spiroloculina disparilis Terquem, 1878, p. 55, pl. 5 (10), fig. 12; Cushman and Todd 1944, p. 35, pl. 5, figs. 22-31.
S. affixa Terquem. Parr 1950, p. 291.

Two specimens, one from 56-C8 and one from 68-157. The species ranges from the Tertiary in Victoria to the Holocene, mostly in lower latitudes, though it has been recorded by Parr (as *S. affixa*) from off Tasmania.

35. **Spiroloculina antillarum** d'Orbigny

Spiroloculina antillarum d'Orbigny, 1839A, p. 166, pl. ix, figs. 3-4; Parr 1932, p. 9, pl. 1, fig. 11; Albani 1968, p. 97, pl. 7.

Parr (1932) recorded and figured *S. antillarum* from Glenelg, S. Aust. This is the common costate *Spiroloculina* of sheltered waters on the southern Australian coast, and in the present collections was found in numbers in W. Bay stations from Altona (Area 5) to Point Lonsdale, and also in the Lower Bay, with a few specimens from Bass Strait stations.

Cushman and Todd (1944), in a revision of the genus *Spiroloculina*, figured three Holocene costate species with rounded periphery, *S. antillarum* from the Caribbean and two new species, *S. scita* and *S. corrugata* from the Indo-Pacific. *S. scita*, with holotype from Samoa, was recorded from a number of S. Australian localities, and Parr's fig. 11 was copied as an additional illustration of the species. Parr noted that his specimen was exceptionally broad, and this was one of the characteristics noted for the new species.

Sixteen specimens from Parr's original Glenelg material were studied and measured for comparison with descriptions and figures of the three species mentioned above, and with specimens of *S. antillarum* from Cuba and the Dry Tortugas (type region). They were found to vary widely in all the characteristics used by Cushman and Todd to differentiate the species i.e. size, length/breadth ratio, obliquity of costae and the presence of a definite neck.

Specimens could be selected which could without difficulty be assigned to each of the three species; smaller specimens with parallel costae to *S. antillarum*, larger and broader specimens with oblique costae to *S. scita,* and even larger but proportionately narrower specimens to *S. corrugata*, with intermediate combinations of characters.

As they obviously represent a single variable population, it seems best to use the prior name of *S. antillarum* for the local costate species, though local specimens are noticeably larger than Caribbean specimens (mean length 1·16 mm as against 0·96 mm, the latter figure derived from maximum and minimum lengths given by Cushman and Todd). This may be due to the unfavourable effect of cooler conditions on reproduction, resulting in increased growth before this takes place, as reported for other foraminiferal species (Loeblich and Tappan 1964, p. C125).

Distribution: 5, 9, 16, 26-27, 30-31, 39, 42, 49-50, 56, 58, 61-62, 67-68.

36. **Spiroloculina communis** Cushman and Todd

Spiroloculina communis Cushman and Todd, 1944, p. 63, pl. 9, figs. 4-5, 7-8.

Except for two doubtful juveniles from Avalon Beach (26) this species is confined to Lower Bay and Bass Strait stations and is nowhere common. The authors record it from the E. coast of Australia.

Distribution: 26, 50, 56, 58, 61, 67.

37. **Spiroloculina lucida** Cushman and Todd

Spiroloculina lucida Cushman and Todd, 1944, p. 70, pl. 9, figs. 30-31; Albani 1968, p. 17, pl. 7, fig. 15.

One specimen from 50-266 has the characteristic convex periphery of this species. It has been recorded several times from the E. coast.

38. **Spiroloculina aequa** Cushman

Spiroloculina antillarum d'Orbigny var. *aequa* Cushman, 1932 etc. (1932), p. 40, pl. 10, figs. 4-5.
S. aequa Cushman. Cushman and Todd 1944, p. 59, pl. 8, figs. 13-15.

A few specimens from 56-C8 are referable to this species, which was described from the Paumotus.

Genus PLANISPIRINOIDES Parr, 1950

39. **Planispirinoides bucculentus** (Brady)

Miliolina bucculenta Brady, 1884, p. 170, pl. cxiv, fig. 3.
Planispirinoides bucculentus (Brady). Parr 1950, p. 287, pl. vi, figs. 1-6, text-figs. 1-5.

Small specimens were found at a number of stations on the Bass Strait coast and the Lower Bay. Parr recorded it from Barwon Heads and also from the Antarctic, where it attains a much larger size.
Distribution: 43, 50, 56, 58-61, 66, 68-69.

Subfamily NODOBACULARIINAE
Genus VERTEBRALINA d'Orbigny, 1826

40. **Vertebralina striata** d'Orbigny

Vertebralina striata d'Orbigny, 1826, p. 283, No. 1, Modèle 81; Chapman 1909, p. 125; Parr 1943, p. 21.

Fairly common on the W. coast, in Corio Bay and Swan Bay, and occurs rarely in the Lower Bay off Rye. Chapman reported it as rare at Beaumaris, and Parr recorded it from Westernport and Spencer Gulf, S. Aust. It was not found outside the Heads, its habitat locally being shallow water in sheltered localities.
Distribution: 5, 26, 28, 39, 49-50, 61, 68.

Family MILIOLIDAE
Subfamily QUINQUELOCULININAE
Genus QUINQUELOCULINA d'Orbigny, 1826

41. **Quinqueloculina baragwanathi** Parr

Quinqueloculina baragwanathi Parr, 1945, p. 196, pl. viii, figs. 6a-c, pl. xii, fig. 3; Albani 1968, p. 98, pl. 7, figs. 16-17.

Common on the Bass Strait coast, penetrating the Lower Bay to a limited extent, and also occurring in Swan Bay. It has a considerable range to the NE. Albani (*loc. cit.*) reports it from Port Hacking, N.S.W., Parr mentions its occurrence at Noumea, and the writer has collected typical specimens from beach sand, Tanna, New Hebrides.
Distribution: 49-50, 56, 58, 59, 61, 66-68.

42. **Quinqueloculina subpolygona** Parr

Quinqueloculina subpolygona Parr, 1945, p. 196, pl. xii, figs. 2a-c; Albani 1968, p. 99, pl. 7, figs. 12-14.

Described from Barwon Heads (56), this species is common in Victorian coastal waters and persists as far N. as Port Hacking (Albani). In Port Phillip it is common in the Lower Bay and the W. coastline as far N. as Altona. Specimens from shallow muddy habitats are somewhat larger than those from the open coast and show a tendency toward irregular growth.
Distribution: 5, 9, 16, 26-28, 31, 42-43, 49-50, 56, 58-62, 67-69.

43. **Quinqueloculina bradyana** Cushman

Miliolina undosa Chapman (non Karrer), 1909, p. 24.
Quinqueloculina bradyana Cushman, 1910 etc. (1917), p. 52, pl. xviii, fig. 2; Parr 1950, p. 290, pl. vi, fig. 11.

Common in Bass Strait stations and in the Lower Bay, it persists on the SW. coast as far as Indented Head, but does not penetrate into Swan Bay or the W. Bay generally.
Distribution: 42-43, 50, 56, 58-62, 66-69.

44. **Quinqueloculina poeyana** d'Orbigny

Quinqueloculina poeyana d'Orbigny, 1839A, p. 191, pl. 11, figs 25-27; Parker, Phleger and Peirson 1953, p. 12, pl. 2, figs. 13-14; Parr 1950, p. 290.

Specimens closely similar to others from the Caribbean (type region) are common on the W. littoral between Altona and Swan Bay, with off-shore records from Corio Bay, Geelong Outer Harbour and the Lower Bay. It also occurs commonly in the upper reaches of the Barwon estuary (56-C9), and rarely at the mouth.

It is distinguished by its slenderness (average of 12 specimens giving a length/breadth ratio of $2 \cdot 15{:}1$), its compact overlapping chambers, produced neck and circular aperture with small tooth. *Q. costata* d'Orbigny (now re-named *Q. tenagos* Parker 1962) was recorded locally by Parr (1932), but this has a proportionately broader and flatter test (Albani 1968, pl. 7, figs. 22-23, and Hedley et al. 1967, pl. 9, fig. 1). It has not been found in the present collections.

Locally, this is a stillwater species, best represented on the W. littoral, and intergrading with the subspecies described below in the Areas near the Heads.

Distribution: 5, 9-10, 16, 26-27, 30-31, 42, 49-50, 56, 60-63, 66, 68-69.

45. Quinqueloculina poeyana d'Orbigny victoriensis subsp. nov.
Pl. 1, figs. 6a-b

Test quinqueloculine, slender, costate, chambers narrow, rounded and projecting to give the test an angular appearance, aperture narrow, parallel-sided, without neck and almost filled by a long straight tooth. It differs from *Q. poeyana* s. str. in having narrower and more projecting chambers and in its distinctive apertural characteristics.

Holotype from 58-C7, Reg. No. G2118. Length 0·57 mm, breadth 0·24 mm, thickness 0·20 mm.

This form was first noted in material from the Lower Pleistocene (Werrikoo Member) of the Glenelg River, W. Vict., in a facies generally similar to that of shallow-water Holocene deposits on the Victorian coastline. It occurs in Bass Strait stations in the present collections, and penetrates into the Lower Bay, where intermediate forms with a loop-shaped aperture are found, together with typical specimens of *Q. poeyana*.

It is characteristic of a high-energy coastline, just as *Q. poeyana* is locally characteristic of low-energy sheltered waters, and apparently has existed in similar environments through the Pleistocene. The existence of intermediate forms in the lower part of Port Phillip, where Bass Strait influence is strong, suggests that the two forms are insufficiently differentiated to justify specific separation, though the morphology of open-coast specimens would otherwise warrant this.

It may be noted that Parr's illustration (1932) of '*Q. costata* d'Orbigny' from San Remo, near the entrance to Westernport, probably refers to this species, as far as can be judged from the apertural characteristics as seen in side view.

Distribution: 43, 50, 56, 58, 60.

46. Quinqueloculina moynensis Collins
Quinqueloculina moynensis Collins, 1953, p. 98, pl. 1, figs. 1a-c; Albani 1968, p. 100.

Since describing this species from the Pleistocene of Port Fairy, Vict., it has been found to be common in Bass Strait beach sands. In the present collections it ranges into the Lower Bay but no further. Recent specimens vary in the degree of striation, some being quite smooth, the majority finely striated on all chambers. This characteristic was not mentioned in the original description, but the figured specimen shows some striation on the penultimate chamber.

Distribution: 43, 50, 56, 58-62, 66-69.

47. Quinqueloculina lamarckiana d'Orbigny
Quinqueloculina lamarckiana d'Orbigny, 1839A, p. 189, pl. 11, figs. 14-15; Parr 1945, p. 196.

Small, sub-circular quinqueloculines with angular periphery are referred with some doubt to this widely recorded species. They are generally distributed in the W. and S. Areas of Port Phillip and also in Bass Strait stations.

Distribution: 5, 9, 16, 26, 28, 30-32, 49-50, 56, 58-59, 61-62, 66-68.

48. Quinqueloculina seminulum (Linne)
Serpula seminulum Linne, 1767, p. 1264, No. 791.
Quinqueloculina seminulum (Linne). d'Orbigny 1826 p. 303, No. 44; Chapman 1909, p. 123 (as *Miliolina*).

This cosmopolitan species is widely distributed within Port Phillip except for the deeper waters of the central basin. Chapman recorded it from Beaumaris. It was not found outside Port Phillip Heads.

Distribution: 3, 5, 7, 10, 13, 16-18, 26-27, 30-31, 36, 38-40, 49-50, 63, 67.

49. Quinqueloculina quinquecarinata Collins
Quinqueloculina quinquecarinata Collins, 1953, p. 360, pl. ii, figs. 8a-c.

One specimen of this small but distinctive species was found at Barwon Heads (56-C8). It was described from the Pleistocene of Port Fairy in an assemblage characteristic of open-coast conditions, and has apparently survived into the Holocene in a similar environment.

50. **Quinqueloculina anguina arenata** Said

Quinqueloculina anguina (Terquem) var. *arenata*
  Said, 1949, p. 9, pl. 1, fig. 25.
Q. anguina (Terquem) var. *wiesneri* Parr, 1950,
  p. 290, pl. iv, figs. 9-10.
Q. anguina arenata Said. Collins 1958, p. 358;
  Albani 1968, p. 98.

This species has a wide distribution in the Indo-Pacific, ranging from the Red Sea to Tasmania. Specimens were found only in Bass Strait and Lower Bay stations.
Distribution: 56, 58, 61, 68.

51. **Quinqueloculina vulgaris** d'Orbigny

Quinqueloculina vulgaris d'Orbigny, 1826, p. 302,
  No. 33; Cushman 1921, p. 417, pl. 87, figs. 1a-c.

A more or less circular quinqueloculine with sub-angular periphery and loop-shaped aperture with simple tooth is referred to this species which has been recorded from the Indo-Pacific and New Zealand. Rare at Barwon Heads (56-C8).

Genus MASSILINA Schlumberger, 1893
52. **Massilina ammophila** (Parr)

Quinqueloculina ammophila Parr, 1932, p. 8, pl. 1.
  fig. 10, text-fig. 1E.
Massilina ammophila (Parr). Parr 1950, p. 292,
  pl. vi, fig. 16.

This species, described from Westernport, is confined to the Lower Bay, where it occurs in some numbers off Rye and near Swan Is.
Distribution: 50, 61-62, 67-68.

Genus PYRGO Defrance, 1824
53. **Pyrgo denticulata** (Brady)

Biloculina ringens Lamarck var. *denticulata* Brady,
  1884, p. 143, pl. 3, figs. 4-5.
Pyrgo denticulata (Brady). Cushman 1918 etc.
  (1929), p. 69, pl. 18, figs. 3-4; Parr 1950, p. 296.

Common in Bass Strait shore sands and in the Lower Bay, but not elsewhere. Specimens are smaller than tropical specimens, and rarely show any signs of denticulation.
Distribution: 43, 50-51, 56, 58-62, 66, 68.

Genus SIGMOILINA Schlumberger 1887
54. **Sigmoilina australis** (Parr)

Quinqueloculina australis Parr, 1932, p. 7, pl. 1, figs.
  8a-c.
Sigmoilina australis (Parr). Parr 1945, p. 197.

Common in Bass Strait stations and rare in limited areas of the Lower Bay.
Distribution: 50, 56, 58, 66, 68.

Genus SIGMOILOPSIS Finlay, 1947
55. **Sigmoilopsis sabulosa** (Parr)

Sigmoilina sabulosa Parr, 1950, p. 292, pl. vi, figs.
  17a-c.

A few specimens from several stations in the Lower Bay and one from outside the Heads (66). As this species has an agglutinated test, it is transferred to *Sigmoilopsis* Finlay.
Distribution: 62, 66, 68.

Genus TRILOCULINA d'Orbigny, 1826
56. **Triloculina trigonula** (Lamarck)

Miliolina trigonula Lamarck, 1804 etc. (1804), p.
  351, No. 3.
Triloculina trigonula (Lamarck). d'Orbigny 1826,
  p. 299, No. 1, pl. 16, figs. 5-9; Parr 1945, p. 197.

Well developed within Port Phillip on the W. littoral and nearby dredge stations between Altona and Kirk Point, and from Indented Head to the Lower Bay and Bass Strait stations.
Distribution: 5-6, 9-10, 16, 30-31, 42-43, 50-51, 56, 58-63, 67, 68-69.

57. **Triloculina striatotrigonula** Parker and Jones

Triloculina striatotrigonula Parker and Jones, 1865,
  p. 438 (nom. nud.); Parr 1941, p. 305.

This common open coast species penetrates the Lower Bay, but is not found further N. As Parker and Jones' reference was a nom. nud., this species should probably be attributed to Parr, who designated Brady's fig. 10 (1884, pl. iv) as the holotype. However, he considered that the specific name was sufficiently descriptive in all the circumstances and accordingly retained the original authorship. His usage has been followed here.
Distribution: 43, 50, 56, 58-62, 66, 68-69.

58. **Triloculina bertheliniana** (Brady)

Miliolina bertheliniana Brady, 1884; p. 166, pl. cxiv,
  fig. 2.
Triloculina bertheliniana (Brady). Parr 1932, p. 10,
  fig. 13.

Most of the records of this reticulated species are from the Tropical Indo-Pacific, but Parr recorded it from shore sand at Torquay, Vict., and one specimen was found at Barwon Heads (56-C8).

59. **Triloculina oblonga** (Montagu)

Vermiculum oblongum Montagu, 1803, p. 522, pl. xiv, fig. 9.
Triloculina oblonga (Montagu). Parr 1932, p. 10, pl. 1, figs. 15a-c; 1945, p. 198.

Common in most Areas where miliolines were found, including the Inner Bay, Lower Bay and Bass Strait.
Distribution: 5, 9-10, 13, 16-17, 26-28, 30-31, 40, 42-43, 48-50, 56, 58-63, 67-69.

60. **Triloculina sabulosa** sp. nov.
Pl. 1, figs. 7a-b

Test small, triloculine, surface agglutinated with much calcareous cement and occasional grains of quartz or heavy minerals which are large in proportion to the size of the test, giving it an irregular outline. Average length 0·35 mm, length/breadth ratio 1·84:1. Aperture rounded on a short produced neck, with a very small tooth discernible in only a few specimens. *Holotype* from 56-C8, Reg. No. G2119. Length 0·43 mm, breadth 0·23 mm, thickness 0·18 mm.

15 specimens were found at Barwon Heads (56-C8) and one at 61-240 in the Lower Bay. The figured specimen somewhat resembles Parr's original figure (1932, pl. 1, fig. 10) of *'Quinqueloculina' ammophila* (*Massilina*, vide supra), but the latter species is much larger by a factor of three, its juvenile specimens are quinqueloculine, and it has been found only in the Lower Bay. This is one of the very few species of *Triloculina* to have an agglutinated test, and appears to be distinct from any described form.

Subfamily MILIOLINELLINAE
Genus MILIOLINELLA Wiesner, 1931
61. **Miliolinella subrotunda** (Montagu)

Vermiculum subrotundum Montagu, 1803, p. 521.
Triloculina subrotunda (Montagu). Parr 1950, p. 203.

Subcircular inflated specimens with a crescentic aperture partly filled by a flap-like tooth are referred to this species, the genotype of *Miliolinella*. They occur in Bass Strait stations and more rarely in the Lower Bay. This is probably the form recorded by Parr (1945) as *Triloculina circularis* Bornemann from Barwon Heads. He later (1950) recorded *T. subrotunda* from off Tasmania.
Distribution: 50, 56, 58, 60-61, 68.

62. **Miliolinella labiosa** (d'Orbigny)

Triloculina labiosa d'Orbigny, 1839A, p. 178, pl. x, figs. 12-14; Parr 1932, p. 220, pl. xxii, fig. 44; 1945, p. 198.

Common in Bass Strait material, occasional in Lower and Inner Bay stations. The wild-growing form which has been distinguished as var. *schauinslandi* is common at Barwon Heads but not elsewhere. Its status appears to be doubtful.
Distribution: 5, 10, 26-27, 30-31, 39, 49-50, 56, 58, 60, 66, 68.

Genus SCUTULORIS Loeblich and Tappan, 1953
63. **Scutuloris parri** sp. nov.
Pl. 1, figs. 8a-c

Test quinqueloculine, sub-oval in outline, somewhat compressed, later chambers overlapping at base, sutures indistinct. Wall thin, lumen of later chambers showing through as dark areas, polished and finely striate. Aperture crescentic with broad semicircular tooth of varying width.
Holotype from 58-C7. Reg. No. G2120. Length 0·48 mm, width 0·40 mm, thickness 0·25 mm.

This may be the form referred by Parr (1945, p. 198) to *Triloculina circularis* Bornemann var. *sublineata* Brady, mentioning its relative compression and 'large, flat. semicircular tooth', and suggesting that it may be a new species. Some specimens appear triloculine, but sectioning shows the quinqueloculine arrangement. Common in Bass Strait stations, and penetrating the Lower Bay to the same extent as many other open-water species.
Distribution: 43, 49-50, 56, 58-62, 66-69.

Family SORITIDAE
Subfamily PENEROPLINAE
Genus PENEROPLIS de Montfort, 1808

64. **Peneroplis planatus** (Fichtel and Moll)

Nautilus planatus var. *β*, Fichtel and Moll, 1798, p. 91, pl. xvi, figs. 1d-f.
Peneroplis planatus (Fichtel and Moll). d'Orbigny 1826, p. 285, Modèle No. 16; Parr 1945, p. 199.

One worn example from 50-266 and a worn juvenile test from 66-292. While this is an extremely common species in S. Aust. Gulf waters, it is open to doubt whether it survives as a living population in Port Phillip.

Suborder ROTALIINA
Superfamily NODOSARIACEA
Family NODOSARIIDAE
Subfamily NODOSARIINAE
Genus NODOSARIA Lamarck, 1812

65. **Nodosaria perversa** Schwager

Nodosaria perversa Schwager, 1866, p. 212, pl. v, fig. 29; Parr 1950, p. 331; Cushman and McCulloch 1950, p. 318, pl. 41, figs. 26-32.

Specimens of this delicately striate species were found only at three stations of Area 68, off Rye. Some show an assymmetry of apertural position suggesting that it should be referred to *Dentalina*, but too few are available for any definite conclusion to be made.

Genus AMPHICORYNA Schlumberger, 1881

66. **Amphicoryna scalaris compacta** Parr

Amphicoryna scalaris (Batsch) var. *compacta* Parr, 1950, p. 328, pl. xi, fig. 24.

Common in Bass Strait beach sands and penetrating into the Lower Bay. This is the local form of *A. scalaris*, a cosmopolitan species.
Distribution: 50, 56, 58-59, 61, 68.

67. **Amphicoryna hirsuta** (d'Orbigny)

Nodosaria hirsuta d'Orbigny, 1826, p. 252.
Amphicoryna hirsuta (d'Orbigny), Parr 1950, p. 328.

This has much the same distribution as the previous species. Parr recorded it from off Tasmania.
Distribution: 50, 56, 58, 61, 68.

Genus ASTACOLUS de Montfort, 1808

68. **Astacolus bassensis** (Parr)

Vaginulina bassensis Parr, 1945, p. 200, pl. xii, figs. 4a-b.

Fairly common at Barwon Heads (56-C8) and other Bass Strait stations, with a few specimens from off Rye in the Lower Bay. The obliquity of sutures and curved axis of fully developed specimens places this species in *Astacolus* rather than *Vaginulina*, in which the later sutures are at right angles to the axis.
Distribution: 56, 58, 61, 66.

Genus DENTALINA Risso, 1826

69. **Dentalina guttifera** d'Orbigny

Dentalina guttifera d'Orbigny, 1846, p. 49, pl. ii, figs. 11-13.

Not uncommon in Bass Strait and Lower Bay stations, with occasional specimens from the W. Bay. Most specimens of this fragile species are broken and show only 2-3 chambers.
Distribution: 28, 30, 32, 56, 61, 66, 68.

70. **Dentalina mutsui** Hada

Dentalina mutsui Hada, 1931, p. 97, text-fig. 50; Parr 1945, p. 201, pl. xii, fig. 5; Albani 1968, p. 102.

Common in Bass Strait shore stations, occasional in the Lower Bay.
Distribution: 56, 58-59, 61.

71. **Dentalina subemaciata** Parr

Dentalina subemaciata Parr, 1950, p. 329, pl. xii, fig. 1.

Fragmentary tests consisting of the first 2-5 chambers, fairly common in Bass Strait shore stations and occasional in the Lower Bay, appear to belong to this species, a slender delicate form unlikely to survive unbroken in open beach conditions. Distribution: 56, 58, 61, 69.

Genus DIMORPHINA d'Orbigny, 1826

72. **Dimorphina** sp. A
Pl. 1, fig. 9

Test subcylindrical with broadly-rounded base and rather more tapering oral end. Specimen has a proloculus and four chambers, the

first three being loosely coiled and slightly compressed, becoming uniserial and circular in section in the last chamber, with a terminal radiate aperture. Surface finely perforate except for an area at the oral end, costate, with about 12 costae which are continuous over the slightly depressed sutures.

Figured specimen from Area 62, station 96. Reg. No. 2121. Length 0·70 mm, breadth 0·31 mm. Only one specimen was found. It appears to be a distinctive form, but in the absence of other examples is described and figured for the record under open nomenclature.

Genus FRONDICULARIA Defrance, 1826

73. Frondicularia compta villosa Heron-Allen and Earland

Frondicularia compta Brady var. *villosa* Heron-Allen and Earland 1924, p. 157, pl. 10, figs. 54-55; Parr 1945, p. 201, pl. ix, fig. 4.

Seven specimens were found, all showing the punctae along the keeled periphery which was the basis for separation of Heron-Allen and Earland's variety described from the Victorian Miocene. As Brady's original specimen of *F. compta* was derived from Bass Strait (Nuttall 1927), it would be worth re-examination to see whether it carries these punctae, which in some specimens are quite obscure and likely to be overlooked.

Distribution: 56, 58, 61, 68.

Genus LAGENA Walker and Jacob, 1798

74. Lagena sulcata Walker and Jacob

Serpula (*Lagena*) *sulcata* Walker and Jacob, 1798, p. 634, pl. xiv, fig. 5.
Lagena sulcata Walker and Jacob. Brady 1884, p. 462, pl. cvii, figs. 23, 26, 33-34; Parr 1945, p. 202; 1950, p. 301; Collins 1958, p. 379; Albani 1968, p. 103.

Common in Bass Strait and in the Lower Bay, with a few specimens from Area 30. Many forms have been referred to this cosmopolitan species. The present specimens have an ovate body with distinct extended neck, in some cases equal in length to the body. Costae are sharp, about 20 in number, and extend to the end of the neck, occasionally with a tendency to twist spirally.

Distribution: 30, 50, 56, 58-61, 66-68.

75. Lagena striata (d'Orbigny)

Oolina striata d'Orbigny, 1839C, p. 21, pl. v, fig. 12.
Lagena striata (d'Orbigny). Brady 1884, pl. cvii, figs. 22 etc.; Parr 1945, p. 202; Collins 1958, p. 379; Albani 1968, p. 103.

Flask-shaped specimens, finely striate, with the striations continued with a spiral twist along the neck, are referred to this species. They are common in Bass Strait and Lower Bay stations, with single specimens from a few Inner Bay stations.

Distribution: 5, 12, 28, 30, 32, 36, 49, 56, 61, 68.

76. Lagena perlucida (Montagu)

Vermiculum perlucidum Montagu, 1803, p. 525, pl. xiv, fig. 3.
Lagena perlucida (Montagu). Cushman and McCulloch 1950, p. 342, pl. 46, figs. 1-2 (gives earlier references); Parr 1945, p. 202; 1950, p. 300; Collins 1958, p. 379.

Rare specimens were found in a number of separated localities indicating a general distribution in Port Phillip and Bass Strait.

Distribution: 5, 28, 30, 32, 56, 68.

77. Lagena crenata Parker and Jones

Lagena crenata Parker and Jones, 1865, p. 420, pl. xviii, figs. 4a-b; Brady 1884, p. 467, pl. cvii, figs. 15, 21.

Rare in Bass Strait and Lower Bay stations, with one specimen from the Inner Bay. It was recorded by Brady from East Moncoeur Is., Bass Strait.

Distribution: 30, 50, 56, 60-61, 68.

78. Lagena striatopunctata Parker and Jones

Lagena sulcata d'Orbigny var. *striatopunctata* Parker and Jones, 1865, p. 350, pl. xiii, figs. 25-27.
Lagena striatopunctata Parker and Jones, Brady 1884, p. 468, pl. lviii, figs. 37, 40.

Two specimens only, from 56-C8 and 68-158. This species has been referred to *Oolina* by Loeblich and Tappan (1953, p. 72) because of the presence of an entosolenian tube, one of the characters which define the family Oolininae, including *Oolina* and *Fissurina*. Apart from this, it is a typical *Lagena*, with a flask-shaped test, produced neck and a simple aperture which is neither radiate nor fissurine.

Three other species recorded or described herein present similar anomalies in respect of the presence or absence of an entosolenian tube, as tabulated below:

TABLE 2

Species	Test form	Aperture	Ento. tube
L. striatopunctata P. and J.	Flask-shaped with produced neck	simple	present
L. ramulosa Chapman	Pyriform	simple	present
O. guttaformis sp. nov.	Drop-shaped and globose	radiate	absent
F. crassiannulata sp. nov.	Compressed and keeled	fissurine	absent

The above evidence, admittedly based on only a few species, suggests that the presence or absence of an entosolenian tube is not a consistent character at the generic level. The combinations listed do not fit the definitions of the genera cited, and could cause complications at the family level. However, the writer considers that generic placement should take into consideration all characteristics rather than depend on one apparently variable character, and has accordingly retained the present species in *Lagena*.

79. **Lagena spiralis** Brady

Lagena spiralis Brady, 1884, p. 408, pl. cxiv, fig. 9; Collins 1958, p. 379; Parr 1950, p. 301.

One specimen from Barwon Heads (56-C8). Parr recorded the species from off Tasmania, but the present specimen may possibly be derived, as the species is found in the Victorian Tertiary.

80. **Lagena distoma-margaritifera** Parker and Jones

Lagena distoma-margaritifera Parker and Jones 1865, p. 357, pl. xviii, figs. 6a-b; Parr 1932, p. 11, pl. i, figs. 16-17.

Common in Bass Strait beach sands, with a range extending well into the Lower Bay.
Distribution: 43, 50, 56, 58-62, 68.

81. **Lagena victoriensis** Parr

Lagena distoma-margaritifera Parker and Jones var. *victoriensis* Parr, 1945, p. 202, pl. xii, fig. 6; Collins 1953, p. 95.

L. distoma-margaritifera, as noted by Brady (1884, p. 459), is very variable in its surface ornament, ranging from bead-like protuberances to a network of low anastomosing ridges, with many intermediate forms. Parr's variety *victoriensis*, on the other hand, is constant in its characteristic ornament of strong rounded longitudinal costae, and was found only in Bass Strait stations (56, 58). Both forms are found in the Pleistocene of Port Fairy, an open coast facies. It is concluded that the two species are validly separated.

82. **Lagena flexa** Cushman and Gray

Lagena flexa Cushman and Gray, 1946, p. 68, pl. 12, figs. 18-21; Cushman and McCulloch 1950, p. 339, pl. 45, fig. 1.

Described from the Californian Pleistocene, the species has a Holocene Indo-Pacific distribution. Typical specimens were found in Areas 56, 58 and 68 (Bass Strait and Lower Bay).

83. **Lagena elongata** (Ehrenburg)

Miliola elongata Ehrenburg, 1854, p. 274, pl. 25, fig. 1.
Lagena elongata (Ehrenburg). Brady 1884, p. 457, pl. lxi, fig. 29; Cushman and McCulloch 1950, p. 338, pl. 44, fig. 14.

Rare at Barwon Heads (56-C8) and in Area 61 in the Lower Bay.

84. **Lagena chasteri** Millett

Lagena chasteri Millett, 1898 etc. (1901), p. 11, pl. i, fig. 11; Sidebottom 1912, p. 398, pl. 16, fig. 34.

Two specimens from Barwon Heads (56-C8) and two from Area 61 in the Lower Bay. They show the surface appearance described by Millett—a clear smooth surface layer with minute pores overlying an opaque, apparently vesicular inner layer, but are more globose in proportions, similar to Sidebottom's fig. 34.

85. **Lagena gracilis** Williamson

Lagena gracilis Williamson, 1848, p. 13, pl. i, fig. 15; Cushman 1932 etc. (1933), p. 33, pl. 8, figs. 5-7.

Slender fusiform costate specimens with bluntly-pointed aboral ends are referred to this species. They occur frequently in Bass Strait and Lower Bay stations.
Distribution: 43, 50, 56, 58-61, 66, 68.

86. **Lagena favoso-punctata** Brady

Lagena favoso-punctata Brady, 1881, p. 62; 1884, p. 473, pl. lviii, fig. 35, pl. lix, fig. 4, pl. lxi, fig. 2.

Specimens with an annulate neck similar to Brady's fig. 35 were common in Bass Strait beach sands and occasionally found in the Lower Bay. Described from Torres Strait, the species is found in the Victorian Tertiaries. Distribution: 50, 56, 58, 60-61, 68.

87. **Lagena implicata** Cushman and McCulloch

Lagena implicata Cushman and McCulloch, 1950, p. 340, pl. 45, figs. 5-7.

Four specimens from Barwon Heads (56-C8) are referable to this species which was described from off California.

88. **Lagena flatulenta** Loeblich and Tappan

Lagena flatulenta Loeblich and Tappan, 1953, p. 60, pl. 11, fig. 10; Albani 1968, p. 103.

Two specimens from Barwon Heads (56-C8) show the angular transition from the globular body to the elongate neck which characterizes this species.

89. **Lagena ramulosa** Chapman

Lagena aculicosta Reuss var. *ramulosa* Chapman, 1909, p. 129, pl. 9, fig. 9; Parr 1932, p. 11, pl. i, fig. 19; 1945 p. 202; Collins 1953, p. 95.

This is the commonest lagenid in Bass Strait shallow-water material and its range extends well into the Lower Bay, with occasional specimens from further N. Typical specimens occur in the Victorian Pleistocene.

Dissection has revealed the presence of a slender entosolenian tube which reaches nearly to the bottom of the lumen. Despite this, it appears to be much more closely related to other pyriform costate lagenids in which this feature has not been reported, such as *L. inepta* Cushman and McCulloch, than to *Oolina*. For reasons adduced earlier (see *L. striatopunctata*) it has been retained in *Lagena* and in view of its distinct characteristics has been raised to specific rank.
Distribution: 36, 43, 50, 56, 58-62, 66-68.

90. **Lagena bassensis** sp. nov.
Pl. 1, fig. 10

Test pyriform, circular in end view, surface ornamented by 18-22 rounded longitudinal costae, occasionally anastomosing toward the base where they meet in a small raised ring, and terminating under a conical cap-like neck which is solid, glassy and pierced by a narrow hole connecting the simple round aperture to the lumen. No entosolenian tube is present. *Holotype* from 56-C8, Reg. No. G2122. Length 0·35 mm, breadth 0·22 mm.

Its closest congener appears to be *L. pseudosulcata* McLean from the Tertiary of North America. '*Oolina*' *tasmanica* Parr has a row of circular pits around the base of the neck. No entosolenian tube is mentioned in the description of the latter species, its aperture is simple and it is probable that it should also be referred to *Lagena*. *L. bassensis* is a common species in Bass Strait stations and in the Lower Bay. Distribution: 50, 56, 58, 61, 68.

91. **Lagena nepeanensis** sp. nov.
Pl. 1, fig. 12

Test flask-shaped, polished, thin-walled and finely perforate, with a solid glassy neck through which can be seen a narrow hole leading from the simple aperture to the lumen. No entosolenian tube is present. *Holotype* from 59-36, Reg. No. G2124. Length 0·38 mm, breadth 0·24 mm.

Common in Bass Strait and in the Lower Bay in the vicinity of Point Nepean, this species differs from *L. laevis* Montagu and *L. flatulenta* Loeblich and Tappan in possessing a solid plug-like neck rather than a slender phialine tube formed by an extension of the chamber wall.
Distribution: 43, 50, 56, 58-61, 66, 68.

92. **Lagena lonsdalensis** sp. nov.
Pl. 1, fig. 11

Test flask-shaped, circular in end view, contour bluntly angled at the broadest part of the test, slightly truncate at the base and ornamented by about 20 flat, slightly rounded costae

with narrow interspaces which continue up the neck to the simple aperture.

Holotype from 58-C7 (Lonsdale Bight), Reg. No. G2123. Length 0·60 mm, breadth 0·25 mm.

Common in Bass Strait shallow-water material, rare in the Lower Bay. This species is distinguished from other flask-shaped costate species by its angular outline and flattened, closely-spaced costae.

Distribution: 56, 58, 61, 68.

93. **Lagena portseaensis** sp. nov.
Pl. 1, fig. 13

Test with globular body smoothly merging into a short bluntly-rounded neck, ornamented by 12-16 narrow costae which are produced up the neck to form a pseudo-radiate aperture, neck solid, glassy and pierced by a narrow hole leading to the lumen. No entosolenian tube is present.

Holotype from 59-214, off Portsea, Reg. No. G2125. Length 0·31 mm, breadth 0·22 mm.

This is one of the species frequently lumped together as *L. acuticosta* Reuss, from which it differs in shape and in possessing a solid glassy neck. Fairly rare in Bass Strait and Lower Bay stations.

Distribution: 50, 56, 58-61, 69.

Genus LENTICULINA Lamarck, 1804
94. **Lenticulina gibba** (d'Orbigny)

Cristellaria gibba d'Orbigny, 1839A, p. 62, pl. 7, figs. 20-21.

Common in Bass Strait shore sands and having a wide distribution in Port Phillip, though in small numbers. Specimens lack the characteristics which distinguish *L. subgibba* Parr (1950, p. 321, pl. xi, figs. 1-2a-b).

Distribution: 5-6, 9, 11, 13, 16-17, 19, 22, 26-28, 30, 32, 36, 50, 55-56, 58-62, 66-68.

95. **Lenticulina australis** Parr

Lenticulina (Robulus) australis Parr, 1950, p. 322, pl. xi, figs. 7-8.

Frequent in Bass Strait shore sands and occurring in small numbers in a few Lower Bay stations.

Distribution: 56, 58-59, 61, 68.

Genus PLANULARIA Defrance 1826
96. **Planularia patens** (Brady)

Vaginulina patens Brady, 1884, p. 533, pl. lxvii, figs. 15-16; Parr 1932, p. 221; 1950, p. 327.
Planularia patens (Brady). Parr 1939, p. 67, fig. 1.

Rare at Barwon Heads and in several stations in the Lower Bay.

Distribution: 56, 60-61, 68.

97. **Planularia australis** Chapman

Planularia australis Chapman, 1941, p. 158, pl. ix, fig. 1.

Specimens from Bass Strait beach sands (Areas 56, 58) are referable to this species, which was described from E. Bass Strait.

Genus SARACENARIA Defrance, 1824
98. **Saracenaria italica** Defrance

Saracenaria italica Defrance, 1820 etc. (1824). p. 176; Chapman 1941, p. 159; Parr 1950, p. 223.

Two specimens were found in Areas 60 and 68 in the Lower Bay.

99. **Saracenaria latifrons** (Brady)

Cristellaria latifrons Brady, 1884, p. 544, pl. lxviii, fig. 19, pl. cxiii, fig. 11.
Saracenaria latifrons (Brady). Parr, 1950, p. 324.

Two specimens were found in Areas 61 and 68 in the Lower Bay.

Genus VAGINULINA d'Orbigny, 1826
100. **Vaginulina vertebralis** Parr

Vaginulina vertebralis Parr, 1932, p. 221, pl. xxii, fig. 42; 1945, p. 200.

Common at Barwon Heads, occasional in the Lower Bay.

Distribution: 50, 56, 58, 61, 68.

Subfamily PLECTOFRONDICULARIINAE
Genus PLECTOFRONDICULARIA Liebus, 1902
101. **Plectofrondicularia** aff. **californica** Cushman

aff. *Plectofrondicularia californica* Cushman, 1926B, p. 39, pl. 6, figs. 9-11.

Two specimens, both incomplete, one showing the aboral end with proloculus, two biserial and four equitant chambers, the other showing the oral end with three chambers were found in Areas 56 and 58. Specimens are elongate and slightly tapering, with concave faces, simple depressed sutures and strongly tricarinate edges. They are clearly different from the Victorian Miocene species *P. australis* (Heron-Allen and Earland). As no complete specimen was found, the form is recorded by open nomenclature.

Genus BOLIVINELLA Cushman, 1927

102. **Bolivinella folium** (Parker and Jones)

Textularia folium Parker and Jones, 1865, pp. 370, 420, pl. xviii, fig. 19.
Bolivinella folium (Parker and Jones). Cushman 1927A, p. 79; Parr 1932, p. 223, pl. xxi, fig. 23; 1945, p. 205.

Fairly common at Barwon Heads and penetrating the Lower Bay to a small extent. Plastogamic pairs are not unusual.
Distribution: 50, 56, 58-59, 66.

103. **Bolivinella pendens** sp. nov.
Pl. 1, figs. 14a-b

Test ovate to pyriform in outline, compressed, biserial throughout. Initial chamber broad and low, subsequent chambers narrow, strongly recurved and drooping toward the periphery. Sutures limbate, projecting, beaded only near centre-line, otherwise smooth. Periphery sharp-edged and bluntly spined at intervals by projecting chambers. Aperture obscure, terminal. Wall hyaline, radiate.
Holotype from 56-C8, Reg. No. G2126. Length 0·50 mm, breadth 0·33 mm, thickness 0·05 mm.

This species occurs together with *B. folium* at Barwon Heads but penetrates further into the Lower Bay. It differs consistently from *B. folium* in its elongate-ovate shape, rather than flabelliform, its strongly recurved and drooping chambers, and its smooth projecting sutures with beading restricted to near the centre-line. It also differs from the tropical *B. elegans* Cushman, which has projecting sutures but a flabelliform outline. Plastogamic pairs have not been seen in this case.
Distribution: 50, 56, 58, 61, 68.

Family POLYMORPHINIDAE d'Orbigny
Subfamily POLYMORPHININAE d'Orbigny
Genus GLOBULINA d'Orbigny, 1839

104. **Globulina gibba globosa** (v. Munster)

Polymorphina globosa von Munster, 1838, p. 386, pl. iii, fig. 33.
Globulina gibba d'Orbigny var. *globosa* (v. Munster). Cushman and Ozawa 1930, p. 64, pl. 17, figs. 8-9; Parr and Collins 1937, p. 199, pl. xii, fig. 13; Parr 1945, p. 205; Albani 1968, p. 104.

Not uncommon in Bass Strait stations but not found within Port Phillip. Fistulose specimens occasionally occurred.
Distribution: 56, 58.

Genus GUTTULINA d'Orbigny, 1839

105. **Guttulina regina** (Brady, Parker and Jones)

Polymorphina regina Brady, Parker and Jones, 1870, p. 241, pl. xli, figs. 32a-b; Chapman 1909, p. 132, pl. x, fig. 4.
Guttulina regina (Brady, Parker and Jones). Cushman and Ozawa 1930, p. 34, pl. 6, figs. 1-2; Parr and Collins 1937, pl. xii, fig. 5, text-figs. 1-7; Parr 1945, p. 204; Albani 1968, p. 104, pl. 8, figs. 14-15.

This is one of the commonest polymorphinids in Port Phillip, being generally distributed except for the central basin and Corio Bay, and is also found in Bass Strait stations. Bay specimens are generally much larger than those from Bass Strait, tending to become considerably elongated. One specimen from Altona Bay (Area 5) measured 1·75 mm in length and 0·58 mm in breadth, compared with 0·62 mm and 0·35 mm for the largest specimen from Barwon Heads. This suggests that stillwater conditions are less than optimum for this species, causing delayed reproduction and consequent increased size.
Distribution: 5-7, 9-10, 13, 17-18, 22, 30-31, 36, 42-43, 50, 56, 58, 60-62, 66-69.

106. **Guttulina yabei attenuata** subsp. nov.

Polymorphina thouini d'Orbigny. Chapman 1909, p. 132, pl. 10, fig. 2.

Guttulina yabei Cushman and Ozawa. Parr and Collins 1937, p. 192 (pars), pl. xiii, figs. 4a-c (non pl. xii, figs. 3-4a-c).

Test elongate, 4-5 times as long as wide, chambers elongated, strongly overlapping and quinqueloculine in arrangement, sutures depressed. Wall thin, smooth and hyaline, aperture radiate.

Holotype: specimen illustrated by Parr and Collins 1937, pl. xiii, fig. 4a-c.

Parr and Collins recorded *G. yabei* from various localities and illustrated a specimen cited herein as subsp. *attenuata* from off Black Rock, Port Phillip (Area 13), which is referred to as 'particularly slender' with the suggestion that the discharge of fresh water from the Yarra River caused foraminifers in this area to be thin-shelled and otherwise atypical. The present material, however, has shown that this elongate form is well distributed in most parts of Port Phillip except the central basin and Corio Bay, including Lower Bay localities close to the Heads. It differs consistently from *G. yabei* s. str. in the proportions of the chambers and of the whole test, and appears to warrant at least subspecific status.

It does not occur in the present Bass Strait material and appears to be confined to Port Phillip, where it is as common as *G. regina* and has much the same distribution. Parr and Collins gave an incorrect plate reference for this form—'Plate XII' should read 'Plate XIII'.
Distribution: 3, 5, 7, 9-10, 13, 17-18, 22, 30-31, 36, 39, 42-43, 48, 50, 60-63, 67-68.

107. **Guttulina silvestrii** Cushman and Ozawa

Guttulina (*Sigmoidina*) silvestrii Cushman and Ozawa, 1930, p. 51, pl. 37, figs. 6-7.
Guttulina silvestrii Cushman and Ozawa. Parr and Collins 1937, p. 197, pl. xii, fig. 11.

Described from the Victorian Miocene and recorded by the authors from the Holocene in S. Aust., this species was found at a number of locations in Port Phillip and also in Bass Strait stations. As noted by the authors it has some resemblance to a juvenile specimen of *Sigmoidella elegantissima* (P. and J.), a much larger species which was not found in the present collections.

Distribution: 5, 7, 11, 16, 18, 27, 30, 43, 50, 56, 58-62, 66, 68-69.

108. **Guttulina pacifica** Cushman and Ozawa

Guttulina (*Sigmoidina*) *pacifica* Cushman and Ozawa, 1930, p. 50, pl. 37, figs. 3, 5.
Guttulina pacifica Cushman and Ozawa. Albani 1968, p. 104, pl. 8, figs. 27-28.

A few specimens were found in dredged material from the W. and S. Areas of Port Phillip.
Distribution: 9, 17, 30, 43, 62, 68.

Genus SIGMOIDELLA Cushman and Ozawa, 1928

109. **Sigmoidella kagaensis** Cushman and Ozawa

Sigmoidella kagaensis Cushman and Ozawa, 1928, p. 19, pl. ii, fig. 14; Parr and Collins 1937, p. 207, pl. xiv, fig. 10.

Four specimens were found in three Areas 56, 58 and 68. All were small in comparison with Japanese specimens, and tended to be drop-shaped in outline rather than somewhat parallel-sided. The species has been recorded from Bass Strait, but the present record must be considered slightly doubtful.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

110. **Sigmomorphina undulosa** (Terquem)

Polymorphina undulosa Terquem, 1878, p. 41, pl. 3 (8), fig. 35a-b.
Sigmomorphina undulosa (Terquem). Cushman and Ozawa 1930, p. 134, pl. 34, figs. 4-5.

Specimens from Bass Strait and Lower Bay stations correspond with the description of this species, previous records of which have been from the Atlantic. As noted by Cushman and Ozawa, some specimens become fistulose in the later chambers.
Distribution: 56, 58, 60-61, 68.

Family GLANDULINIDAE Reuss
Subfamily GLANDULININAE Reuss
Genus GLANDULINA d'Orbigny 1839

111. **Glandulina** cf. **laevigata** d'Orbigny

cf. *Glandulina laevigata* d'Orbigny, 1826, p. 252, No. 1, pl. 10, figs. 1-3.

One specimen from Barwon Heads could be referred to this well-known species, or it could possibly be the microspheric form of *G. antarctica* Parr (1950, p. 334, pl. xii, figs. 8-9a-b), which is practically indistinguishable in the absence of the megalospheric form. It could also be a reworked fossil, as the species occurs in the Victorian Tertiary. Until more material is available, the question is left open.

Genus LARYNGOSIGMA Loeblich and Tappan, 1953

112. **Laryngosigma williamsoni** (Terquem)

Polymorphina williamsoni Terquem, 1878, p. 37.
Sigmomorphina williamsoni (Terquem). Cushman and Ozawa 1930, p. 138, pl. 38, figs. 3-4; Parr and Collins 1937, p. 205, pl. xv, fig. 5; Parr 1932, p. 12, pl. 1, fig. 20; 1945, p. 205.
Laryngosigma williamsoni (Terquem). Loeblich and Tappan 1953, p. 84, pl. 16, fig. 1.

Typical specimens were found at three stations, Areas 49, 56 and 68.

113. **Laryngosigma australiensis** sp. nov.
Pl. 1, figs. 15a-b

Test compressed with rounded periphery, outline varying from parallel-sided to sub-elliptical, chambers in sigmoid series, at first originating at the base, later successively removed and becoming practically uniserial in some specimens. Sutures slightly depressed and recurved, aperture fissurine with a very short entosolenian tube, wall hyaline.

Holotype from 56-C8, Reg. No. G2127. Length 0·44 mm, breadth 0·19 mm, thickness 0·09 mm.

This species is similar to *L. williamsoni* in its parallel-sided form, but differs in that later chambers are successively further removed from the base, in some specimens becoming practically uniserial. The aperture is fissurine rather than radiate as in *L. williamsoni*.

Six specimens were found at Barwon Heads (56) and one at Lonsdale Bight (58). Others have been found in the Lower Pleistocene (Werrikoo Member) of the Glenelg River, and in the Middle Miocene (Balcombian) beds underlying at the same location. The Barwon Heads specimens could have been derived from

nearby coastal or submarine Tertiary exposures, but the Lonsdale Bight specimen is from an area where considerable downthrow has occurred and admixture from Tertiary sources is accordingly unlikely. It is therefore concluded that the species has persisted like many others of the Nodosaridae from Tertiary times.

Subfamily OOLININAE
Genus OOLINA d'Orbigny, 1839

114. **Oolina caudigera** (Wiesner)

Lagena (Entosolenia) caudigera Wiesner, 1931, p. 119, pl. 18, fig. 214.
Oolina caudigera (Wiesner). Loeblich and Tappan 1953, pl. 13, figs. 1-3.

Smooth globose specimens with a long entosolenian tube and a basal spine are referred to this species. They are fairly common at Barwon Heads (56) and occur also just inside the Heads. Some have a roughened, semi-opaque surface.

Distribution: 50, 56, 58-59.

115. **Oolina borealis** Loeblich and Tappan

Entosolenia costata Williamson, 1858, p. 9, pl. 1, fig. 18 (non *Oolina costata* Egger, 1857).
Oolina costata (Williamson). Parr 1950, p. 303.
Oolina borealis Loeblich and Tappan, 1954, p. 384.

A few specimens were found at Barwon Heads (56-C8) but not elsewhere.

116. **Oolina hexagona** (Williamson)

Entosolenia squamosa (Montagu) var. *hexagona* Williamson, 1848, pl. ii, fig. 23; 1858, p. 13, pl. i, fig. 32.
Oolina hexagona (Williamson). Parr 1950, p. 304.

Specimens showing the typical hexagonal reticulation were found in Areas 50 and 68.

117. **Oolina melo** d'Orbigny

Oolina melo d'Orbigny, 1839C, p. 20, pl. v, fig. 9; Parr 1950, p. 303.

Specimens showing the characteristic rounded scale-like ornament arranged in vertical rows were found in Areas 56 and 68.

118. **Oolina pseudocatenulata** (Chapman and Parr)

Lagena pseudocatenulata Chapman and Parr, 1937, p. 65, pl. vii, fig. 7.

Oolina pseudocatenulata (Chapman and Parr). Parr 1950, p. 304, pl. viii, fig. 5.

Rare specimens referable to this species were found at several Bass Strait and Lower Bay stations.

Distribution: 56, 58, 60, 68.

119. **Oolina variata** (Brady)

Lagena variata Brady, 1884, p. 461, pl. lxi, fig. 1.
Oolina variata (Brady). Parr 1950, p. 303.

Specimens were not uncommon at three Bass Strait and Lower Bay stations. Most were finely though irregularly costate rather than wrinkled as in Brady's figure, but as noted by Parr the species is variable in this respect.

Distribution: 56, 58, 68.

120. **Oolina guttaformis** sp. nov.
Pl. 1, figs. 16a-b

Test elongate-oval to pyriform, circular to somewhat compressed in end view, polished and finely perforate except at the apertural end and base which are clear, aperture radiate, leading to the base of the solid neck, no entosolenian tube.

Holotype from 56-C8, Reg. No. G2128. Length 0·40 mm, breadth 0·22 mm thickness 0·19 mm.

This species presents some anomalies. The compression of most specimens suggests *Fissurina*, but the aperture is radiate, not fissurine, and there is no entosolenian tube. Consideration has been given to the possibility of it being the initial chamber of a polymorphinid, but this is discounted by its size, frequency of occurrence and the absence of any adult polymorphinid with which it could be associated in the stations in which it occurs. It is concluded that it is best recorded as *Oolina*.

Distribution: 56, 58-59. Fairly common at Barwon Heads (56).

Genus FISSURINA Reuss, 1850

121. **Fissurina lacunata** (Burrows and Holland)

Lagena lacunata Burrows and Holland, 1895, p. 205, pl. i, figs. 12a-b.

Fissurina lacunata (Burrows and Holland). Parr 1945, p. 60; 1950, p. 310; Albani 1968, p. 105, pl. 8, fig. 16.

A common species in Bass Strait and Lower Bay stations.

Distribution: 50, 56, 58-61, 67-68.

122. **Fissurina contusa** Parr

Fissurina contusa Parr, 1945, p. 203, pl. ix, fig. 6; Collins, 1958, p. 380.

This species has much the same distribution as *F. lacunata* but is generally less frequent.

Distribution: 50, 56, 58-61, 68.

123. **Fissurina lucida** (Williamson)

Entosolenia marginata var. *lucida* Williamson, 1858, p. 10, pl. i, figs. 22-23.
Lagena lucida (Williamson). Sidebottom 1904 (1906), p. i, pl. i, figs. 9-12.
Fissurina lucida (Williamson). Parr 1945, p. 203.

This species is common in Bass Strait and Lower Bay stations, and is the only fissurinid to be well represented N. of these Areas, being moderately common in littoral and near-shore stations in the W. Bay from Altona to Avalon Beach, Corio Bay. Specimens are consistent in form but variable in the width of the opaque peripheral bands.

Distribution: 5, 13, 16-17, 26-27, 42, 49-50, 56, 58-62, 67-68.

124. **Fissurina pacifica** Parr

Fissurina pacifica Parr, 1950, p. 314, pl. ix, figs. 10a-b.

Typical specimens are not uncommon at Barwon Heads (56) and occur in a few other Bass Strait and Lower Bay stations.

Distribution: 50, 56, 61, 68.

125. **Fissurina orbignyana** Seguenza

Fissurina orbignyana Seguenza, 1862, p. 66, pl. ii, figs. 25-26; Collins 1958, p. 331.

Large and robust specimens referable to this cosmopolitan species were found in beach material from Areas 56 and 58, but not elsewhere.

126. **Fissurina quinqueannulata** Parr

Fissurina quinqueannulata Parr, 1950, p. 310, pl. viii, figs. 13a-b.

C

Common in Bass Strait stations and extend-
ing well into the Lower Bay. It may be noted
that the form described and figured by Parr
(1945) as 'F. orbignyana Seguenza var.' from
Barwon Heads is apparently identical with this
species, though Parr did not note this in his
later work.
Distribution: 43, 50, 56, 58-59, 61, 68.

127. Fissurina marginata (Walker and Boys)

Serpula (Lagena) marginata Walker and Boys, 1784,
    p. 2, pl. 1, fig. 7.
Fissurina marginata (Walker and Boys). Parr 1950,
    p. 305.

Common in two Bass Strait beach stations
(56, 58) and found also at one station in the
Lower Bay (61). Parr's record was from off
Tasmania.

128.   Fissurina pseudoformosa sp. nov.
Pl. 2, figs. 20a-b

Test elongate-pyriform in outline with pro-
duced phialine neck, compressed, with a
narrow, thick, tubulated keel of even width
surrounding the body of the test and slightly
notched at the base. A double row of radial
tubules penetrate the keel itself, flanked by a
single row of pores on each side which pene-
trate the test wall. The lower part of the neck
and the base are ornamented by raised retic-
ulate patches formed by elongated pits with
intervening ridges. Aperture is terminal and
circular, opening into a centrally-placed ento-
solenian tube extending about half-way down
the body of the test.
Holotype from 56-C8, Reg. No. G2132. Length
0·40 mm, breadth 0·20 mm, thickness 0·13
mm.
    This species differs from both F. formosa
(Schwager) and Parr's variety angusticarinata
(1950, p. 313, pl. ix, fig. 8) in its much
narrower keel and in the presence of reticulate
ornament at the base and neck. In this latter
respect it is similar to one of the forms figured
by Brady (1884, pl. lx, figs. 18-19) as F.
formosa, but again differs in the narrow even
keel. Thirteen specimens were found at Barwon
Heads (56) and others in Areas 50, 58 and 68.

129. Fissurina crassiannulata sp. nov.
Pl. 2, figs. 17a-b

Test sub-ovate in outline, compressed, cen-
tral area very slightly inflated and surrounded
by a solid, rounded keel which is somewhat
thicker than the central part, finely tubulate on
the outer edges and with a clear, non-tubulate
central band. Wall hyaline, clear and polished.
Aperture slit-like, opening directly into the
lumen without an entosolenian tube.
Holotype from 58-C7, Reg. No. G2129.
Length 0·33 mm, breadth 0·27 mm, thickness
0·10 mm.
    The distinctive feature of this species is the
thick, rounded glassy keel which surrounds the
comparatively depressed body of the test. The
absence of an entosolenian tube is an anoma-
lous feature of this species.
Distribution: 50, 56, 58-59, 61, 66, 68.

130. Fissurina furcata sp. nov.
Pl. 2, figs. 18a-b

Test pyriform in outline, compressed, peri-
phery bluntly keeled. Short costae originate on
the neck and branch downward to form two
low inner keels which surround the body of the
test. Aperture fissurine with an entosolenian
tube extending about halfway to the base.
Central area clear and very finely perforate.
Holotype from 56-C8, Reg. No. G2130.
Dimensions: length 0·28 mm, breadth 0·16
mm, thickness 0·09 mm.
    This species is characterized by the complex
of costae originating on the neck and forming
a five-keeled periphery. It occurs at Barwon
Heads and in six stations in the Lower Bay.
Distribution: 43, 50, 56, 61, 68.

131. Fissurina multipunctata sp. nov.
Pl. 2, figs. 19a-b

Test oval, compressed, with a bluntly-
rounded non-perforate keel, wall conspicuously
punctate, aperture fissurine with an entoso-
lenian tube extending for about 0·3 of the
length of the test.
Holotype from 66-292, Reg. No. G2131.
Length 0·24 mm, breadth 0·19 mm, thickness
0·12 mm.

This small species resembles *F. plana* (Matthes) in shape and in the possession of a blunt keel, but differs in the punctate character of the wall which resembles morocco leather in surface texture.
Distribution: 56, 58, 66, 68.

132. **Fissurina semimarginata** (Reuss)

Lagena marginata Williamson var. *semimarginata* Reuss, 1870, p. 468; Brady 1884, p. 446, pl. cix, fig. 17.
Fissurina semimarginata (Reuss). Loeblich and Tappan 1953, p. 78, pl. 14, fig. 3.

Single specimens were found at Barwon Heads (56-C8) and at Lonsdale Bight (58-C7) which correspond exactly to Loeblich and Tappan's fig. 3 and with Brady's fig. 17 (not 18-19 which do not appear to be conspecific).

133. **Fissurina foraminata** (Matthes)

Lagena foraminata Matthes, 1939, p. 81, pl. 6, fig. 110.

Single specimens from Barwon Heads and from Lonsdale Bight show the narrow keel and conspicuously perforate body of this species, described from the Tertiary of Germany.

134. **Fissurina fasciata** (Egger)

Oolina fasciata Egger, 1857, p. 270, pl. 17, fig. 15.
Lagena fasciata (Egger). Sidebottom 1904 etc. (1906), p. 6, pl. 1, figs. 13-16.

Specimens are sub-circular and somewhat compressed, with rounded periphery and a broad fissurine aperture. White opaque peripheral bands on each side meet at the base in some specimens and are separated in others. Rare at Lonsdale Bight (58) and in Areas 61 and 68.

Superfamily BULIMINACEA
Family BULIMINOIDIDAE
Genus BULIMINOIDES Cushman *emend.* Sieglie, 1970

135. **Buliminoides gracilis** (Collins)

Buliminella gracilis Collins, 1953, p. 102, pl. 1, figs. 8a-b; Albani 1968, p. 106, pl. 8, fig. 9.
Buliminoides gracilis (Collins). Sieglie 1970, p. 112 (in text).

Described originally from the Pleistocene of Port Fairy, W. Victoria, this species has been found to be fairly common in Holocene Victorian shallow-water deposits, and as far N. as Port Hacking, N.S.W. (Albani 1968). Following the re-definition of *Buliminoides* by Sieglie (1970) it is transferred to that genus. It is frequent in Bass Strait and Lower Bay stations.
Distribution: 50, 56, 58, 61, 66, 68.

136. **Buliminoides madagascariensis** (d'Orbigny)

Bulimina madagascariensis d'Orbigny, 1826, p. 270, No. 17.
Buliminella madagascariensis (d'Orbigny). Cushman and Parker 1947, p. 68, pl. 17, figs. 15-17.
Buliminoides madagascariensis (d'Orbigny). Sieglie 1970, p. 112 (in text).

Large and well-developed specimens of both the megalospheric and microspheric forms were common at Barwon Heads (56) and occurred in smaller numbers at other Bass Strait and Lower Bay stations.
Distribution: 50, 56, 58, 60, 66, 68.

Family SPHAEROIDINIDAE
Genus SPHAEROIDINA d'Orbigny, 1826

137. **Sphaeroidina bulloides** d'Orbigny

Sphaeroidina bulloides d'Orbigny, 1826, p. 267, No. 1, Modèles No. 65; Parr 1945, p. 214; 1950, p. 347.

Common at Barwon Heads, occasional in other Bass Strait stations and rare in the Lower Bay.
Distribution: 50, 56, 58, 61, 66.

Family BOLIVINITIDAE
Genus BOLIVINA d'Orbigny, 1839

138. **Bolivina subreticulata** Parr

Bolivina subreticulata Parr, 1932, p. 12, pl. i, figs. 21a-b; 1950, p. 339.

Four specimens from Barwon Heads and isolated single specimens from the Lower Bay and Geelong Outer Harbour. This species appears to be rare in southern waters. Parr described it from Raine Is. and recorded it from Point Lonsdale only, later recording a single specimen from off Tasmania.
Distribution: 38, 50, 56, 66, 68.

139. **Bolivina pseudoplicata** Heron-Allen and Earland

Bolivina pseudoplicata Heron-Allen and Earland, 1929 etc. (1930), p. 81, pl. 3, figs. 36-40; Cushman 1937A, p. 166, pl. 19, figs. 12-20; Parr 1945, p. 206.

This species is common and widely distributed in all parts of Port Phillip except the central basin, and also common in Bass Strait stations. Distribution: 5-6, 10-11, 13, 16-18, 22, 26-28, 30-31, 36, 38, 40, 42, 48-50, 56, 58-63, 66-69.

140. 'Bolivina' subtenuis Cushman

Bolivina subtenuis Cushman, 1936, p. 57, pl. 8, fig. 10; 1937A, p. 148, pl. 19, figs. 33-34; Collins 1953, p. 101, pl. i, fig. 7.

The characteristics of this species, including the irregular arrangement of apparent chamberlets and in particular the assymmetrically-placed aperture with radial grooves separate it from *Bolivina* s. str. The latter characteristic suggests a relationship with *Buliminoides*, which is reinforced by the occasional example with resorbed and open apertural area, similar to post-plastogamic tests of *Buliminoides* illustrated by Sieglie (1970). Insufficient material is as yet available to pursue this question further.
Distribution: 50, 56, 58, 68, single specimens only.

141. **Bolivina robusta** Brady

Bolivina robusta Brady, 1881, p. 27; 1884, p. 421, pl. liii, figs. 7-9; Parr 1950, p. 340; Collins 1953, p. 96; Albani 1968, p. 106.

Common in Bass Strait stations and in the Lower Bay, and at scattered locations within Port Phillip.
Distribution: 7, 11, 19, 29-30, 32-33, 35-36, 49-50, 54, 56, 59-61, 66-68.

142. **Bolivina compacta** Sidebottom

Bolivina robusta Brady var. *compacta* Sidebottom, 1904 etc. (1905), p. 15, pl. 3, fig. 73.
Bolivina compacta Sidebottom. Cushman 1910 etc. (1911), p. 36, pl. 3, fig. 73, text-fig. 58; Parr 1945, p. 206, pl. ix, fig. 8; 1950, p. 338.

Fairly common in Bass Strait and Lower Bay stations, also found in the W. Bay between Altona and Avalon.

Distribution: 5, 13, 16-18, 26, 28, 30, 42, 49-50, 56, 58-61, 66, 68.

143. **Bolivina decussata** Brady

Bolivina decussata Brady, 1881, p. 28; 1884, p. 423, pl. liv, figs. 12-13; Sidebottom 1918, p. 128; Parr 1950, p. 338.

Rare specimens were found in Areas 58, 61 and 68.

144. **Bolivina lobata** Brady

Bolivina lobata Brady, 1881, p. 28; 1884, p. 425, pl. liii, figs. 22-23.

Five specimens from Barwon Heads and one each from Areas 50 and 68. Tests are biserial throughout, and the ornament on the angular shoulders of the later chambers tends to be raised-reticulate as suggested by Brady's figures, though his description reads 'more or less granulate'.

Genus BRIZALINA Costa, 1856

145. **Brizalina striatula** (Cushman)

Bolivina striatula Cushman, 1918 etc. (1922), p. 27, pl. 3, fig. 10; Parr 1950, p. 239.

An elongate bolivine with rounded periphery, having the lower half of the test finely striate is referred to this species, which was recorded by Parr from the Antarctic. The degree of striation varies a good deal, from fairly coarse to almost indistinguishable, in specimens which in all other respects appear to be conspecific. No retral processes or basal lobes appear on the chambers, and accordingly the species should be transferred to *Brizalina*.

Common in most parts of Port Phillip, the exception being the central basin where only one specimen was found. Also occurs at Barwon Heads.
Distribution: 3, 5-7, 10-11, 13, 16-19, 22-23, 25-30, 33, 35-36, 38-40, 42, 49-50, 54-56, 59, 61-62, 67-68.

Genus RECTOBOLIVINA Cushman, 1927

146. **Rectobolivina digitata** Parr

Rectobolivina digitata Parr, 1945, p. 206, pl. ix, fig. 10.

Common in Bass Strait and Lower Bay stations, and rare in a few isolated stations in the E. and W. parts of Port Phillip.

151. **Bulimina elongata** d'Orbigny

Bulimina elongata d'Orbigny, 1826, p. 279, No. 9;
Cushman and Parker 1947, p. 108, pl. 25, figs.
14-17.

A slender elongate bulimine with inflated but not undercut chambers is referred to this species, described from the Miocene of Austria, and recorded from the Holocene in the Indo-Pacific. It is a common species in Port Phillip, but is absent from Bass Strait stations and from Areas immediately inside the Heads. Like *B. marginata*, it occurs in many of the sparse assemblages of the central basin.

Distribution: 2-3, 5-7, 9-13, 17-20, 22-23, 27-28, 30-33, 35-37, 42, 47, 53-55, 61-63, 67-68.

152. **Bulimina echinata** d'Orbigny

Bulmina echinata d'Orbigny, 1826, p. 279, No. 9;
Cushman and Parker 1947, p. 108, pl. 25, figs.
14-17; Parr 1939, p. 67, pl. (unnumbered), fig. 7.

A comparatively rare species mostly confined to the Lower Bay off Rye, with occasional specimens occurring further N. Most specimens are fairly typical, but some elongate forms are only differentiated from *B. elongata* by the spinous growth on the lower half of the test. The species was recorded by Parr from the Pliocene of Jemmy's Point, E. Gippsland, Vict., and present specimens agree well with specimens from that locality.

Distribution: 32, 55, 61, 68.

Subfamily PAVONININAE
Genus PAVONINA d'Orbigny, 1826
153. **Pavonina triformis** Parr
Pl. 2, fig. 21

Pavonina triformis Parr, 1933, p. 29, pl. vii, figs. 1,
2a-c, 3a-b.

This species was described from the lower clay beds of Yellow Bluff, Torquay, Vict., regarded by Carter (1958) as being of Longfordian (Lower Miocene) age. It is distinguished from the well-known Indo-Pacific genotype *P. flabelliformis* by its extended and sharply trihedral early triserial stage and its reduced biserial to uniserial stage, which never reaches the degree of envelopment of the initial portion shown by mature specimens of the latter species.

Specimens referable to this species were found in Areas 50, 56, 58, 61 and 68. While the occurrence at Barwon Heads (56) might be suspect as possibly remanié, no evidence of such admixture has been found in the Lower Bay (50, 61, 68), and it is therefore concluded that all specimens are Holocene. The nine specimens found are all small, roughly triangular in shape and show at the most one uniserial chamber. Most have a bluntly angular trihedral portion; the figured specimen from 50-233 (Reg. No. G2133) is however sharply keeled, similar to Parr's fig. 2.

Parr reported his species from localities giving a time range of Longfordian to Batesfordian in Victoria. A slide from his collection contains a specimen labelled 'Lower Miocene (F3) Hilly country W. of Semarang, Java', suggesting a wide range during the Tertiary. The writer has found specimens in material from a Mines Department bore at Hamilton, Vict., together with *Orbulina universa* d'Orb. and *Biorbulina bilobata* (d'Orb), suggesting Bairnsdalian (Upper Mid. Miocene) age. A single specimen was also found in the Cheltenhamian (Upper Miocene) of Beaumaris, Vict.

Parr considered that post-Lower Miocene specimens were referable to *P. flabelliformis*, having evolved from *P. triformis* by Pliocene time, and illustrated his argument by fig. 5, which undoubtedly represents the former species from the Lower Pliocene of Forsyth's, Grange Burn, Hamilton. However, the present evidence suggests that the presumed ancestral form persisted to the Holocene in the cooling waters of S. Vict., while the full development of *P. flabelliformis* took place in the warmer waters of the Indo-Pacific. In this regard, Parr's record (1933, p. 29) of a 'small, imperfect' specimen of *P. flabelliformis* from the Post-Tertiary of the Boneo bore, near Sorrento, strongly suggests that the present species was involved.

Genus CHRYSALIDINELLA Schubert, 1908
154. **Chrysalidinella dimorpha** (Brady)

Chrysalidina dimorpha Brady, 1881, p. 24; 1884, p. 338, pl. xlvi, figs. 20-21.
Chrysalidinella dimorpha (Brady). Schubert 1908, p. 243; Parr 1945, p. 260; Albani 1968, p. 107.

One specimen only, from Area 62. Parr reported it from Barwon Heads and Albani from Port Hacking, N.S.W. It is a rare species S. of the tropics.

Genus FIJIELLA Loeblich and Tappan, 1962
155. **Fijiella simplex** (Cushman)

Trimosina simplex Cushman, 1929, p. 158, fig. 2a-b.
Fijiella simplex (Cushman). Loeblich and Tappan 1962, p. 109.

This species is not uncommon in Bass Strait shore sands and its range extends into the Lower Bay. The supplementary cribrate apertures on the oral face are quite obvious and distinguish it from *Reussella*.
Distribution: 43, 50, 56, 58-62, 69.

Genus REUSSELLA Galloway, 1933
156. **Reussella armata** (Parr)

Reussia armata Parr, 1932, p. 224, pl. xxii, figs. 49-50a-b (non *Reussia* McCoy 1854).
Reussella armata (Parr). Parr 1945, p. 206.

Rare specimens were found in Area 51 (Lower Bay) and 58, 66 (Bass Strait). This species is fairly common in S. Aust. but distinctly rare in Victorian waters. Parr recorded it from Barwon Heads.

Family UVIGERINIDAE
Genus EUUVIGERINA Thalmann, 1952
157. **Euuvigerina bassensis** (Parr)

Uvigerina bassensis Parr, 1950, p. 340, pl. xii, figs. 19-20; Collins 1953, p. 96; Albani 1968, p. 107, pl. 8, fig. 10.

Common in Bass Strait stations and extending into the Lower Bay, but not ranging further into Port Phillip. Both the stout and slender forms figured by Parr occurred. The narrow simple toothplate of this species places it in *Euuvigerina*.
Distribution: 43, 50, 56, 58-63, 66-67, 69.

158. **Euuvigerina compacta** sp. nov.
Pl. 2, figs. 22a-b

Test sub-cylindrical, about 2·5 times as long as broad, both ends broadly rounded, chambers closely appressed and tending to recurve toward the base, sutures depressed, surface finely costate with costae partly continuous over chambers, aperture rounded, terminal with a short neck, toothplate narrow, attached to foramen of previous chamber.
Holotype from 56-C8, Reg. No. G2134. Length 0·50 mm, breadth 0·21 mm.

The distinctive features of this species are the more or less parallel-sided form with broadly rounded base and the closely appressed and recurved chamber shape. Specimens were found at five Bass Strait and Lower Bay stations.
Distribution: 50, 56, 58, 68.

Genus SIPHOUVIGERINA Parr, 1950
159. **Siphouvigerina canariensis** (d'Orbigny)

Uvigerina canariensis d'Orbigny, 1839B, p. 138, pl. i, figs. 25-27; Brady 1884, p. 573, pl. lxxiv, figs. 18-19.

Present in Bass Strait stations and having a somewhat unusual distribution in Port Phillip, ranging up the E. coast from the Lower Bay to the head of the Bay at Altona, and occurring at two stations in Geelong Outer Harbour.
Distribution: 5-6, 13, 16, 28, 36, 48, 50, 58, 61, 63, 66, 68.

Genus TRIFARINA Cushman, 1923
160. **Trifarina angulosa** (Williamson)

Uvigerina angulosa Williamson, 1858, p. 67, pl. v, fig. 140.
Angulogerina angulosa (Williamson). Parr 1945, p. 207; 1950, p. 341.
Trifarina angulosa (Williamson). Loeblich and Tappan 1964, p. C571, fig. 450, 1-3.

Common at most Bass Strait and Lower Bay stations.
Distribution: 43, 49-50, 56, 58-62, 66-69.

161. **Trifarina bradyi** Cushman

Trifarina bradyi Cushman, 1918 etc. (1923), p. 99, pl. 22, figs. 3-9; Chapman and Parr 1937, p. 98.

Occurs in eight Bass Strait and Lower Bay stations. Chapman and Parr recorded it from off Tasmania.

Distribution: 50, 56, 58, 61-62, 68.

162. Trifarina elliptica (Dorreen)

Angulogerina elliptica Dorreen, 1948, p. 293, pl. 38, fig. 9.

Specimens corresponding with the figure and description of this species, described from the Upper Eocene of New Zealand, are fairly common in the Lower Bay and Bass Strait. Specific characteristics include the lack of surface ornament, the rounded axial ridges formed by backward-extending lobes of successive chambers and the kidney-shaped terminal aperture with a slight lip.

Distribution: 43, 49-50, 56, 59-62, 67-68.

Genus HOPKINSINA Howe and Wallace, 1932

163. Hopkinsina pacifica Cushman

Hopkinsina pacifica Cushman, 1933, p. 86, pl. 8, figs. 16a-b.

Eleven specimens referable to this species were found in material from Geelong Outer Harbour (28, 30). It was described from Tonga in the tropical Pacific.

164. Hopkinsina victoriensis sp. nov.
Pl. 2, figs. 23a-b

Test slightly compressed, tapering from initial end to greatest width in the final chamber, triserial in early stage, becoming biserial in later chambers, wall ornamented by strong longitudinal costae which tend to become obsolete on the final chamber, sutures depressed, aperture irregularly rounded with everted lip. *Holotype* from 16-282, Reg. No. G2135. Length 0.39 mm, breadth 0.14 mm, thickness 0.10 mm.

Other specimens were found in the N. Bay and in the Lower Bay. It does not appear to be referable to any described species, the nearest being *H. hancocki* Todd, which differs in having high, sharp and serrated costae and a long apertural neck.

Distribution: 6, 16, 61, 68 (six stations).

Superfamily DISCORBACEA
Family DISCORBIDAE
Subfamily DISCORBINAE
Genus DISCORBIS Lamarck, 1804

165. Discorbis dimidiatus (Parker and Jones)

Discorbina dimidiata Parker and Jones, 1862, p. 201, text-fig. 32b.
Discorbis vesicularis (Lamarck) var. *dimidiata* (Parker and Jones). Parr 1932, p. 227, pl. xxi, figs. 27a-c, 29a-c.
Discorbis dimidiatus (Parker and Jones). Parr 1945, p. 208; Hedley, Hurdle and Burnett 1967, p. 33, pl. 1, fig. 4, pl. 10, figs. 1-3, text-figs. 28-43; Albani 1968, p. 108, pl. 8, figs. 18, 24.

This well-known species is very common in Bass Strait and Lower Bay stations. Elsewhere in Port Phillip it is represented only by odd specimens, usually small and somewhat broken and eroded, except for the beach stations C1 (Altona) and C2 (Kirk Point) where it is present in numbers and well developed. It is probably more widely distributed in the sublittoral waters of Port Phillip than the present collections indicate.

Amongst the material studied were some strongly biconvex specimens with an excess of secondary thickening on both faces, which in the extreme case fills the umbilical area with a clear projecting boss from which radial thickenings curve outward along the sutures. In such specimens the spiral side is dome-like and polished, the early chambers being clearly visible through the secondary thickening. These appear to be linked with typical *D. dimidiatus* by equally biconvex specimens in which the umbilical flaps are heaped up and welded together in an irregular mass.

In view of the considerable variability of this species (Hedley et al. 1967) it is considered that such specimens are individual variations caused by the secretion of an excess of secondary calcite.

Distribution: 5-6, 10, 16-17, 22, 26-27, 31, 39, 42-43, 49-51, 56, 58-62, 66-69.

Genus BRONNIMANNIA Bermudez, 1952.

166. Bronnimannia haliotis (Heron-Allen and Earland)

Discorbina haliotis Heron-Allen and Earland, 1924, p. 173, pl. xiii, figs. 99-101.

Discorbis haliotis (H.-A. and E.). Parr 1939, p. 68; Collins 1953, p. 96.
Planulina haliotis (H.-A. and E.). Chapman 1941, p. 176.
Bronnimannia haliotis (H.-A. and E.). Collins 1958, p. 406; Todd, 1965, p. 27, pl. 5, fig. 2.

Three specimens were found at Barwon Heads (56) and two in Area 68. The species was described from the Middle Miocene of Victoria and has since been recorded from the Holocene of W. Aust., Bass Strait and the Great Barrier Reef.

Genus DISCORBINELLA Cushman and Martin, 1935

167. **Discorbinella infrapapillata** sp. nov.
Pl. 2, figs. 24a-c

Test trochospiral, sub-circular, concavo-convex with sharply keeled and lobulate periphery. Dorsal side convex, partly evolute, with sigmoid-radial flush sutures, surface polished and finely perforate, with pores concentrated toward edges of chamber wall, the central part being only lightly pored. Ventral side concave with shallow umbilicus, surface papillate, sutures sinuous and slightly depressed, with a re-entrant sinus forming an apertural flap. Peripheral aperture oval with slightly raised lip, at junction of last chamber and previous whorl, umbilical aperture a low arch below flap, obscure and usually visible on the last chamber only. Wall structure radial and hyaline.
Holotype from 56-C8, Reg. No. G2136. Diameter 0·33 mm, thickness 0·15 mm.

This small species is not typical of *Discorbinella*, as the dorsal (spiral) side is not completely evolute, showing only the initial chamber and the inner edges of a few chambers in the first whorl. This is a matter of degree, and the apertural characteristics clearly place it in this genus. It may be noted that the papillae are randomly distributed, not in radial lines as in some species of the Glabratellidae.
Distribution: 50, 56, 58, 66-68.

Genus EPISTOMINELLA Hasewa and Maruhasi, 1944

168. **Epistominella exigua** (Brady)

Pulvinulina exigua Brady, 1884, p. 696, pl. ciii, figs. 13-14.
Pulvinulinella exigua (Brady). Parr 1950, p. 351.
Epistominella exigua (Brady). Parker, Phleger and Peirson 1953, p. 43, pl. 9, figs. 35-36; Todd 1965, p. 30, pl. 10, fig. 1.

One specimen of this deep-water species was found at Barwon Heads (56), in a mixed assemblage of shallow-water and off-shore species.

Genus NEOCONORBINA Hofker, 1951

169. **Neoconorbina frustata** (Cushman)

Discorbis frustata Cushman, 1933, p. 88, pl. 9, fig. 2.
Rosalina frustata (Cushman). Collins 1958, p. 404.
Neoconorbina frustata (Cushman). Todd 1965, p. 18, pl. 1, fig. 7.

Three specimens of this rare species were found at Barwon Heads (56) and two more in Area 68. It has hitherto been regarded as being of tropical distribution.

170. **Neoconorbina tuberocapitata** (Chapman)

Discorbina tuberocapitata Chapman, 1900, p. 11, pl. i, fig. 9.
Neoconorbina tuberocapitata (Chapman). Todd 1965, p. 17, pl. 1, figs. 8-9.

One specimen from 50-233 shows the long arcuate chambers, thin flanged base and columnar form of the early part of the test which characterize this species. It differs in that the apex is slightly excavated rather than rounded, but is considered to be referable to Chapman's species, which was described from Funafuti and recorded by Todd from Fiji.

171. **Neoconorbina terquemi** (Rzehak)
Pl. 2, figs. 25a-c

Discorbina terquemi Rzehak, 1888, p. 228.
Neoconorbina terquemi (Rzehak). Todd 1958, p. 96; 1965, p. 16, pl. 5, fig. 6; Loeblich and Tappan 1964, p. C582, fig. 457, 5a-c.

This small species is referred with some reservations. It has the long arcuate overlapping chambers and the distinct apertural flap of *N.*

terquemi, but may have as many as five chambers in the last whorl, though most specimens have three. It is more compressed than the specimen figured by Todd, being closer to that figured by Loeblich and Tappan in this respect. *Figured specimen* from 10-15, Reg. No. G2137. Major diameter 0.26 mm, thickness 0.10 mm.

It is confined to Port Phillip in the present material, being best represented in the W. Bay where it is fairly common. This is another cause for doubt, as *N. terquemi*, from the records, has a wide oceanic range. It may represent a remanent population which is differentiating under stillwater conditions, but the differences observed do not appear to warrant separation.

Distribution: 5-7, 9-10, 13, 16-17, 19, 25-28, 30-31, 36, 40, 42, 47, 49-50, 60-63, 67-68.

Genus PATELLINELLA Cushman, 1928

172. **Patellinella inconspicua** (Brady)

Textularia inconspicua Brady, 1884, p. 357, pl. xlii, figs. 6a-c.
Patellinella inconspicua (Brady). Cushman 1928, p. 5, pl. 1. figs. 8a-c; Parr and Collins 1930, p. 92, pl. 4, fig. 7; Parr 1945, p. 208; Albani 1968, p. 108, pl. 8, figs. 22-23.

A common species in Bass Strait and the Lower Bay. The writer has earlier (1958, p. 407) expressed the opinion that the many tropical records of this species are erroneous, though it undoubtedly extends as far N. as Sydney (Albani 1968).

Todd (1965, p. 9, pl. 1, fig. 3) has figured a specimen referred to this species which is closer to the Bass Strait form than most tropical records. However, it differs in having lower and broader chambers which do not interdigitate at the junction, and lacks the conspicuous pores and the discorbine early chambers which characterize *P. inconspicua*.

Distribution: 43, 49-50, 56, 58-62, 66-69.

Genus PLANODISCORBIS Bermudez, 1952

173. **Planodiscorbis rarescens** (Brady)

Discorbina rarescens Brady, 1884, p. 651, pl. xc, figs. 2-4.
Discorbis rarescens (Brady). Parr 1945, p. 210.

Planodiscorbis rarescens (Brady). Bermudez 1952, p. 40.

Occurs in small numbers in Bass Strait and Lower Bay stations. Parr recorded it from Barwon Heads.

Distribution: 56, 58-59, 61, 66, 68.

174. **Planodiscorbis grossepunctatus** (Parr)

Discorbis grossepunctatus Parr, 1945, p. 210, pl. x, figs. 4a-c.

One specimen only, from Lonsdale Bight (58-C7) corresponds with Parr's figure in most respects, except that it has six chambers instead of four in the final whorl and is about 0.6 the size. The addition of one chamber 'much larger than the others' would probably eliminate this difference. Parr noted that this species is similar to '*Discorbis*' *rarescens* in being involute on the dorsal side and evolute on the ventral, thus placing it in *Planodiscorbis*.

Genus PLANULINOIDES Parr, 1941

175. **Planulinoides biconcavus** (Jones and Parker)

Discorbina biconcava Jones and Parker, 1862, p. 201; Parker and Jones 1865, p. 422, pl. xix, figs. 10a-b; Brady 1884, p. 653, pl. xci, figs. 2-3; Chapman 1909, p. 136.
Planulinoides biconcavus (Jones and Parker). Parr 1941, p. 305, text-figs. a-c; Loeblich and Tappan 1964, p. C584, fig. 458, 4-6.
Discorbinella biconcava (Jones and Parker). Parr 1945, p. 211.

A very common species in Bass Strait and the Lower Bay, occurring in nearly all the stations. Specimens clearly show the discorbine apertural flaps which, together with the peripheral aperture and bicarinate form characterize this species. Todd (1965) has recorded this species from tropical deep-water localities, but has been unable to confirm the existence of these flaps. However, her figure (pl. 11, fig. 1) shows a form which is comparatively thin and parallel-sided, whereas Bass Strait specimens develop a flaring growth in width in the later chambers, giving the characteristic concavity to the sides of the test. *P. concavus* is locally a shallow-water species, and it appears likely that the deep-water specimens of the

'Albatross' collections are specifically if not generically distinct.

Distribution: 42-43, 49-50, 56, 58-62, 66-69.

176. **Planulinoides planoconcavus** (Chapman, Parr and Collins)

Planulina biconcava (Jones and Parker) var. *planoconcava* Chapman, Parr and Collins ms. (in Parr 1932, p. 232, pl. xxii, figs. 34a-c).

Discorbis planoconcavus (Chapman Parr and Collins), Chapman, Parr and Collins 1934, p. 561, pl. ii, figs. 40a-c.

Discorbinella planoconcava (Chapman Parr and Collins), Parr 1945, p. 211, pl. xi, figs. 1-2; Albani 1968, p. 108.

Frequent at Barwon Heads (56) and occurring at other Bass Strait and Lower Bay stations, but not nearly as common as *P. biconcavus*, from which it differs only in its assymmetrical development.

Distribution: 50, 56, 58-59, 61, 68.

177. **Planulinoides disparilis** (Heron-Allen and Earland)

Discorbina disparilis Heron-Allen and Earland, 1922, p. 205, pl. vii, figs. 20-22.

Discorbis disparilis (H.-A. and E.). Parr 1932, p. 230, pl. xxii, figs. 32a-c.

Discorbinella disparilis (H.-A. and E.). Parr 1945, p. 212.

This species occurs frequently at Barwon Heads (56-C8), and its distribution extends into the Lower Bay. Though its periphery is not so obviously bicarinate as in the previous species, it is nevertheless truncate with a shallow concavity between the two rounded edges in which the peripheral aperture is sited, and should therefore be referred to *Planulinoides* rather than to the single-keeled *Discorbinella*.

Distribution: 50, 56, 58-61, 66, 68.

Genus PSEUDOHELENINA gen. nov.

Test trochospiral, biconvex, spiral side more strongly convex with all chambers visible, umbilical side flatter, deeply umbilicate and showing only the last whorl. Chambers inflated, usually six in the last whorl, periphery broadly rounded and lobulate. Sutures depressed, almost radial on umbilical side, oblique and somewhat sinuate on the spiral side. Primary aperture umbilical with a small projecting flap, secondary sutural apertures developed on spiral side, narrowly triangular in shape and extending for about half the length of the chamber along the spiral suture and for a short distance along the septal suture. Obsolete sutural apertures indicated by a short, narrow imperforate lip occur in the radial sutures of the umbilical side about halfway to the periphery, but do not open to the interior. Wall hyaline, radial and coarsely perforate, except for a small clear area on the distal face of the final chamber.

Genoholotype: Valvulineria collinsi (Parr)

This genus is erected to accept a discorbine species having supplementary sutural apertures on the spiral side, with an indication of obsolete sutural slits on the umbilical side. The generic name does not imply a close relationship with *Helenina* Saunders 1961, but rather indicates a similarity in the possession of sutural supplementary apertures. It differs from that genus in being coarsely instead of finely perforate, the primary aperture does not extend on to the spiral side and the sutural apertures are separate rather than continuations of the primary aperture. Also, the well developed radial slits on the umbilical side of *Helenina* are absent or represented only by an obsolete lip. The genotype *Helenina andersoni* (Warren) is confined to a salt marsh habitat in Louisiana and the West Indies, whereas the present form is found only in fully marine conditions.

178. **Pseudohelenina collinsi** (Parr)
Pl. 2, figs. 26a-c

Discorbis collinsi Parr, 1932, p. 230, pl. xxii, figs. 33a-c.

Valvulineria collinsi (Parr). Parr 1945, p. 212.

Descriptions emended as above, with the characteristics of the genus. Fresh specimens usually have all but the last one or two of the supplementary apertures closed off by later deposition. Fossil specimens from the Pleistocene shell sands of Goose Lagoon, W. Vict., show clearly the sutural slits opening into the chambers, presumably because of leaching and solution of the thin infilling. This observation prompted re-examination of recent specimens from the present collections, in which the spe-

cies is common, resulting in the recognition of characters which preclude reference to *Valvulineria* and do not appear to be provided for in any described genus. Parr's figures show a suggestion of the sutural slits, but (as the writer is aware, having drawn the originals) they were not recognized as features of any importance in the classification of forty years ago.

Figured specimen from Goose Lagoon, Reg. No. G2138.

Distribution: 43, 56, 59-62, 66-68.

Genus TORRESINA Parr, 1947

179. **Torresina involuta** (Sidebottom)

Discorbina involuta Sidebottom, 1918, p. 225, pl. vi, figs. 16-17.
Discorbinella involuta (Sidebottom). Parr 1945, p. 212.
Torresina involuta (Sidebottom). Parr 1947, p. 131, pl. i, figs. 2a-c, 3a-c, text-fig. 2.

This species is not infrequent at Barwon Heads and occurs in a few stations in the Lower Bay. Loeblich and Tappan (1964) place this genus in the Epistomaridae, a family defined inter alia as possessing supplementary chamberlets on the umbilical side. The only reference to supplementary chamberlets in *Torresina* derives from one specimen only, an unusually large specimen of *T. haddoni* from Trinity Inlet, Cairns, Qd., which develops structures on the last two chambers which were not found in the larger series of specimens of that species from Raine Is. These structures, however, appear to be only an enlarged and recurved modification of the ventral apertural flaps which occur in other species of the genus, rather than true chamberlets as in *Epistomaria*.

Considering the more or less truncate periphery, the peripheral aperture and the ventral flaps, the only major respect in which this genus differs from *Planulinoides* is in the incomplete subdivision of the chambers by secondary septa. It is therefore concluded that its proper place is in the Discorbinae together with *Planulinoides* and *Discorbinella*.

Distribution: 50, 56, 59, 61, 68.

Subfamily BAGGININAE
Genus BAGGINA Cushman, 1926

180. **Baggina phillipinensis** (Cushman)

Pulvinulina phillipinensis Cushman, 1921, p. 331, pl. lviii, figs. 2a-c.
Cancris phillipinensis (Cushman). Parr 1939, p. 69, pl. (unnumbered), figs. 18a-c.
Baggina phillipinensis (Cushman). Parr 1945, p. 213; Albani 1968, p. 110.

Four specimens from Barwon Heads and single specimens from seven stations in Bass Strait and the Lower Bay. They are small compared with tropical specimens, but appear to be conspecific.

Distribution: 50, 56, 58, 60-61, 68-69.

Genus CANCRIS de Montfort, 1808

181. **Cancris auriculus** (Fichtel and Moll)

Nautilus auricula Fichtel and Moll, 1803, pp. 108, 110, pl. xx, figs. a-f.
Cancris auriculus (Fichtel and Moll). Cushman and Todd 1942, p. 74, pl. 18, figs. 1-11, pl. 23, fig. 6.

Three specimens from Barwon Heads and one each from Areas 50 and 62 are small but otherwise typical of this cosmopolitan species.

Genus RUGIDIA Heron-Allen and Earland, 1928

182. **Rugidia simplex** sp. nov.
Pl. 2, figs. 27a-c

Test irregularly globose, consisting of a proloculus and 3-4 chambers in roughly trochospiral arrangement. Dorsal side coarsely pored and in a few examples obscured by irregular rugose thickening, sutures slightly curved and nearly flush. Ventral side very finely perforate and comparatively clear, no discernible aperture, sutures radial and slightly depressed. Wall thick, hyaline and radial in structure.

Holotype from 56-C8, Reg. No. G2139. Major diameter 0·60 mm, thickness 0·50 mm.

This peculiar species is tentatively referred to *Rugidia* on account of its few, thick-walled chambers and apparent cruciform arrangement, which on sectioning is seen to be trochospiral. The clear ventral area suggests a relationship with the Baggininae. The specimen figured is one of the more regularly formed. 21 specimens were found at Barwon Heads, and one or two in Areas 59-60, 62, 66 and 68.

Genus VALVULINERIA Cushman, 1926

183. Valvulineria minutissima sp. nov.
Pl. 2, figs. 28a-c

Test small, trochospiral, plano-convex to unequally biconvex and varying considerably in thickness, sub-circular in outline, periphery rounded and slightly lobulate, 7-9 chambers in the last whorl. Dorsal side strongly convex, all chambers visible, sutures recurved and slightly depressed. Ventral side flat to slightly convex, sutures depressed and slightly recurved, inner ends of chambers extend toward umbilicus forming a rudimentary flap. Umbilicus shallow and infilled with fine papillae which extend to a varying degree over the inner ends of the chambers. Wall polished and finely pored, transparent on inner side of chambers with pores more closely spaced toward periphery on both dorsal and ventral sides. Wall structure hyaline, radial and monolamellar.

Holotype from 5-C1, Reg. No. G2140. Greatest diameter 0·29 mm, thickness 0·13 mm.

The generic position of this small species is somewhat doubtful. It has been placed in *Valvulineria* because of its monolamellar wall, rounded periphery and rudimentary umbilical flap, though the papillate umbilical area is atypical. It has a discontinuous distribution in shallow water, occurring in Areas 5 and 6 at the N. end of Port Phillip, in Swan Bay (49) and in the Barwon estuary (56-C9).

184. Valvulineria victoriensis sp. nov.
Pl. 3, figs. 29a-c

Test trochospiral, periphery rounded and lobulate. Dorsal side nearly flat, all chambers visible, 7-9 in the last whorl, sutures slightly recurved and depressed. Ventral side more convex, with depressed umbilicus, sutures nearly radial and depressed. Inner ends of chambers extended to form flaps which fill the umbilicus and are returned toward the periphery to cover the inner ends of the sutures, forming a stellate pattern. Aperture obscure, presumably below umbilical flaps. Wall finely and closely pored, with clear transparent areas bordering the septal sutures in immature

specimens. Wall structure hyaline, radial and monolamellar.

Holotype from 49-C5, Reg. No. G2141. Greater diameter 0·43mm, thickness 0·20 mm.

This species has much the same shallow-water distribution as the last, occurring at the same localities and also at Kirk Point (16). Its generic affinities are clearer, due to the well-developed apertural flaps which fill the shallow umbilicus and the inner ends of the depressed sutures.

Distribution: 5-6, 16, 49, 56.

Family SIPHONINIDAE
Genus SIPHONINA Reuss, 1850

185. Siphonina tubulosa Cushman

Siphonina tubulosa Cushman, 1924, p. 40, pl. 13, figs. 1-2; Parr 1950. p. 362; Collins 1958, p. 413.

Frequent at Barwon Heads but rare elsewhere, in Bass Strait and Lower Bay stations only.

Distribution: 50, 56, 60-61, 68.

Superfamily SPIRILLINACEA
Family SPIRILLINIDAE
Subfamily SPIRILLININAE
Genus SPIRILLINA Ehrenberg, 1843

186. Spirillina vivipara Ehrenberg

Spirillina vivipara Ehrenberg, 1843, p. 442, pl. iii, sec. 7, fig. 41; Parr 1950, p. 347; Collins 1958, p. 399; Albani 1968, p. 110.

This cosmopolitan species is fairly rare in the collections, occurring at two Bass Strait and four Lower Bay stations.

Distribution: 56, 61, 66, 68.

187. Spirillina inaequalis Brady

Spirillina inaequalis Brady, 1879 etc. (1879), p. 278, pl. viii, fig. 25; Parr 1945, p. 199; 1950, p. 350.

This is the commonest spirilline in Victorian coastal waters, occurring in most of the Bass Strait and Lower Bay stations.

Distribution: 50, 56, 58-59, 61-62, 66, 68.

188. Spirillina pectinimarginata aspinosa Parr

Spirillina pectinimarginata Chapman Parr and Collins var. *aspinosa* Parr, 1950, p. 348, pl. xiii, figs. 7a-b.

One specimen was found at 68-158 off Rye. Parr described it from off Tasmania and stated that it occurred in the Victorian Miocene.

Genus PLANISPIRILLINA Bermudez, 1952

189. **Planispirillina dimidiata** Wiesner

Spirillina dimidiata Wiesner, 1931, p. 128, pl. xxi, fig. 250; Parr 1950, p. 350, pl. xiii, figs. 15-16.

Two specimens from Barwon Heads (56-C8) agree with the figures of this species. Records are all from the Antarctic.

190. **Planispirillina denticulata** (Brady)

Spirillina limbata Brady var. *denticulata* Brady, 1884, p. 632, pl. lxxxv, fig. 17.
S. denticulogranulata Chapman, 1909, p. 133, pl. x, fig. 6.
S. denticulata Brady. Parr 1950, p. 351.
Planispirillina denticulata (Brady). Collins 1958, p. 399.

Specimens were found at three Bass Strait stations and four in the Lower Bay, but it was nowhere common.
Distribution: 50, 56, 58, 61, 66, 68.

Genus TURRISPIRILLINA Cushman, 1927

191. **Turrispirillina depressa** Parr

Turrispirillina depressa Parr, 1950, p. 351, pl. xiii, figs. 17-18.

This small species, described from off Tasmania, occurs in Bass Strait and Lower Bay stations and is also found in the W. Bay. It occurs in some numbers on the muddy S. beach of Swan Bay (49-C6). Parr's record was from comparatively deep water, but the present evidence indicates that the species is well adapted to shallow stillwater conditions.
Distribution: 17, 26, 31, 49-50, 58, 60, 68-69.

Subfamily PATELLININAE
Genus PATELLINA Williamson, 1858

192. **Patellina corrugata** Williamson

Patellina corrugata Williamson, 1858, p. 46, pl. iii, figs. 86-89; Parr and Collins 1930, p. 90, pl. iv, figs. 1-5; Parr 1945, p. 91; 1950, p. 352; Collins 1958, p. 401.

Fairly rare at Barwon Heads and in five Lower Bay stations, single specimens at two stations in the W. Bay.
Distribution: 26, 31, 50, 56, 61-62, 68.

Superfamily ROTALIACEA
Family ROTALIIDAE
Subfamily ROTALIINAE
Genus AMMONIA Brünnich, 1772

193. **Ammonia aoteanus** (Finlay)
Pl. 3, figs. 30a-c

Streblus aoteanus Finlay, 1939 etc. (1940), p. 461.
Ammonia aoteanus (Finlay). Hedley, Hurdle and Burnett 1967, p. 47, pl. 11, figs. 4a-c, text-figs. 56-60.

This is the common form of *Ammonia* found in Victorian coastal, bay and estuarine waters, and previously cited by authors as *A. beccarii* (Linne). Compared with specimens of the latter species from the Adriatic it is a much simpler test, lacking the exogenous growth in the form of sutural beading dorsally and dentate edging to the ventral sutures which characterize *beccarii*. Local specimens vary in the degree of umbilical infilling from a completely open umbilicus to one almost entirely infilled with irregular pillars. New Zealand specimens appear to show similar variation, as illustrated by Hedley et al. (1967). One of the more infilled specimens is illustrated here.
Figured specimen from 16-C2, Reg. No. G2142. Diameter 0·69 mm, thickness 0·37 mm.

It is a euryhaline species, being common on the open coast and also in brackish estuarine waters where it is often the dominant species. It is widely distributed in Port Phillip, being present in nearly every station in the Lower Bay, central basin and the W. Bay N. of Kirk Point. The reason for its almost complete absence from Geelong Outer Harbour and Corio Bay is not apparent, since it is common in the less favourable environments of the central basin and the N. Areas near the mouth of the Yarra River, where foraminiferids are scarce and few in species.
Distribution: 2-3, 5-7, 10-13, 16-20, 22-23, 25, 31-33, 35-36, 38, 42, 44-45, 48-51, 53-56, 58-63, 66-69.

194. **Ammonia tepida** (Cushman)

Rotalia beccarii (Linne) var. *tepida* Cushman, 1926A, p. 79, pl. 1.
Streblus tepidus (Cushman). Collins 1958, p. 414.

This species occurs in small numbers on the W. coast of Port Phillip from Altona to Corio Bay, and in Swan Bay, mostly in shallow-water or littoral material. Specimens were compared with others obtained from Cushman's original Dry Tortugas material and were found to match very well. They are consistently smaller than adult specimens of *A. aoteanus* (0·3 to 0·35 mm diam.) and when compared with juveniles of similar size differ in their more distinct pore pattern, clear non-perforate margins along the inner edge of the chamber adjoining the spiral suture on the dorsal side, and in the absence of non-perforate edges and tips to the umbilical extensions of the chambers on the ventral side.

Distribution: 5-7, 16, 26, 28-31, 37, 42, 49.

Family ELPHIDIIDAE
Subfamily ELPHIDIINAE
Genus ELPHIDIUM de Montfort, 1808

This genus as earlier understood (Cushman 1939) has been subdivided by later authors into a number of genera which, in some cases at least, appear to be based on characteristics of doubtful value. For the purposes of this work the older usage has been followed, all species present being retained in *Elphidium*.

195. **Elphidium argenteum** Parr

Elphidium argenteum Parr, 1945, p. 216, pl. xii, figs. 7a-b.
Cribroelphidium argenteum (Parr). Hedley, Hurdle and Burdett 1967, p. 48, pl. 12, figs. 2a-b.

Common in Bass Strait and in the Lower Bay, with a few specimens from the W. Bay. This species has been referred to *Cribroelphidium* Cushman and Bronnimann by Hedley et al. (1967) on the grounds of possessing solid septal bridges instead of hollow retral processes, and a simpler canal system than *Elphidium* s. str. However, the definition of *Cribroelphidium* (Loeblich and Tappan 1964) includes multiple apertures with areal as well as basal pores, of which the former do not occur in this species.

Distribution: 5, 10, 16, 18, 27-28, 30-32, 42-43, 56, 58-63, 68-69.

196. **Elphidium advenum** Cushman

Polystomella advena Cushman, 1922, p. 56, pl. 9, figs. 11-12.
Elphidium advenus (Cushman). Cushman 1939, p. 60, pl. 16, figs. 31-35.
E. advenum (Cushman). Parr 1945, p. 216; Albani 1968, p. 111, pl. 10, fig. 6.

This is the commonest species of *Elphidium* in the Survey area, occurring throughout Port Phillip and in the Bass Strait stations, usually in considerable numbers.

Distribution: all Areas providing samples, except 20-21, 23, 44, 52.

197. **Elphidium limbatum** (Chapman)

Polystomella macella (Fichtel and Moll) var. *limbata* Chapman, 1909, p. 142, pl. 10, figs. 9a-b.
Elphidium macellum (F. and M.) var. *limbatum* Chapman. Cushman 1939, p. 52, pl. 14, fig. 5.

This small but distinctive species is widely distributed in Port Phillip, from whence it was described, and also occurs in Bass Strait stations. It has little in common with *E. macellum* and is accordingly treated as a distinct species. Chapman's description is in error to the extent that the sutures are not limbate, but depressed and infilled with granular growth which obscures the retral processes in many specimens. The apparent limbate areas are in fact the clear inflated walls of the anterior part of the chambers. The periphery is slightly keeled as in Chapman's fig. 9a.

Distribution: 3, 5-7, 9-10, 12-13, 16-19, 22, 25-26, 29-32, 36-40, 45-46, 48, 50, 56, 58-63, 66-69.

198. **Elphidium selseyense** (Heron-Allen and Earland)

Polystomella striato-punctata (Fichtel and Moll) var. *selseyense* Heron-Allen and Earland, 1908 etc. (1909), p. 695, pl. 21, figs. 2a-c.
Elphidium selseyense (H.-A. and E.). Cushman 1939, p. 60, pl. 16, figs. 26-28.

Small thin-walled specimens with rounded and lobulate periphery, depressed umbilicus with a varying degree of pustular infilling, depressed sutures with very short retral processes and basal pored aperture are referred to this species. Comparison has been made with topotype specimens of *E. selseyense* and with Cuban specimens of *E. poeyana* d'Orbigny. The latter

species, which has been recorded from Australian waters (Albani 1968) is similar in general morphology to *E. selseyense*, but is distinguished by its possession of areal apertures in the form of large pores in the apertural face. This character has been used to distinguish *Cribroelphidium* Cushman from *Cribrononion* Thalmann, the present specimens lacking an areal aperture coming within the definition of the latter genus. It appears to be a valid distinction, at least at the specific level.

Feyling-Hansen (1972) considers that this species (as *E. excavatum* Terquem forma *selseyense*) is confined to the boreal region, but it is noted that the authors of the species recorded it from the Indian Ocean and the Antarctic.

Distribution: 5-6, 10, 26, 55-56, 59, 63, 68, nowhere common.

199. **Elphidium simplex** Cushman

Elphidium simplex Cushman, 1932 etc. (1933), p. 52, pl. 12, figs. 8-9; 1939, p. 62, pl. 17, fig. 10; Albani 1968, p. 113, pl. 10, fig. 4.
Elphidium sp. cf. *simplex* Cushman. Parr 1945, p. 216, pl. ix, fig. 8.

This species is well distributed in Port Phillip except in the central basin, and was also found in Bass Strait stations. Frequent in the stations in which it occurs.

Distribution: 3, 5-7, 9-10, 13, 16-18, 22, 26-27, 31, 36, 49-50, 55-56, 58-59, 61-62, 66, 69.

200. **Elphidium evolutum** (Chapman)

Polystomella striatopunctata (Fichtel and Moll) var. *evoluta* Chapman, 1913, p. 173, pl. 16, fig. 9.

This small species was described from the Tertiary of Victoria (Mallee Bores). The present specimens correspond with Chapman's description and figure in all respects except size, with a maximum diameter of 0.29 mm as against the original of 0.446 mm. This is not considered to justify any distinction even at the subspecific level. The evolute character, unusual in this genus, occurs only because the inward edges of the chambers do not extend over the umbilicus, thus exposing the earlier whorls which, however, are usually obscured

by granular growth. There is no tendency to uncoil as implied by Cushman in considering this species to be a possible precursor of *Ozawaia*, which develops a uniserial stage.

It has a scattered distribution in the N. Areas of Port Phillip, and does not extend into Corio Bay, the Lower Bay or Bass Strait.

Distribution: 5-7, 10-13, 16-19, 22-23, 30, 32-33, 35-36, 47, 53-55.

201. **Elphidium crispum** (Linne)

Nautilus crispus Linne, 1758, p. 709.
Elphidium crispum (Linne). Cushman 1939, p. 50, pl. 13, figs. 17, 21; Parr 1943, p. 20; Albani 1968, p. 111, pl. 10, fig. 7.

Specimens with a prominent glassy umbo are referred with some doubt to this cosmopolitan species. They are smaller than Mediterranean specimens but match the smaller specimens of this species from a N. Atlantic dredging. Confined to Bass Strait and Lower Bay stations.

Distribution: 56, 58-60, 66, 68-69.

202. **Elphidium macellum** (Fichtel and Moll)

Nautilus macellus Fichtel and Moll, 1798, p. 66, pl. 10, figs. h-k.
Polystomella macella (F. and M.). Chapman 1909, p. 141.
Elphidium macellum (F. and M.). Cushman, 1939, p. 51, pl. 14, figs. 1-3, pl. 15, figs. 9-10; Parr 1945, p. 217; 1950, p. 372.

Specimens with depressed and papillate umbilicus are referred with equal doubt to this often cited species. They are small compared to Mediterranean specimens and vary considerably in degree of compression, but otherwise appear to be similar. Distribution is general throughout the Survey area, except for some of the more barren stations of the central Bay.

Distribution: 5-7, 9-13, 16-19, 22, 25-28, 30-33, 36-40, 42-43, 45-50, 55-56, 58-63, 67-69.

203. **Elphidium sculpturatum** Cushman

Elphidium sculpturatum Cushman, 1936A, p. 84, pl. 15, figs. 2a-b.

This species was described from material dredged by the writer off Black Rock, Port Phillip, (Area 13) in the late 1920s, and does not appear to have been recorded since Cush-

man's description. Specimens from the type sample have a distinctive chalk-white appearance which emphasizes the bold modelling of septal ridges and retral processes.

The species occurs mainly in the N. half of Port Phillip where it is a common species. together with Swan Bay, Barwon River (C9) and a few isolated occurrences in the Lower Bay.

Distribution: 5-6, 10-12, 16-19, 22, 25-33, 36, 49, 51, 55-56 (C9), 61, 63, 66.

204. Elphidium granulosum sp. nov.
Pl. 3, figs. 33a-c

Test small, planispiral with up to 13 inflated chambers in the last whorl, periphery broadly rounded and lobulate, sutures depressed with short sutural bridges, umbilicus depressed. Surface hispid with short granular outgrowths which occur both on the chamber and in the sutures and umbilicus, completely masking the retral processes in earlier chambers. Aperture obscure, probably basal.

Holotype from 49-C5, Reg. No. G2145. Major diameter 0·33 mm, thickness 0·17 mm. This small species is restricted to Swan Bay (49) in the present material. It differs from *E. hispidulum* Cushman in being umbilicate rather than umbonate, and in lacking circumferential costae, and does not appear to have been previously described.

205. Elphidium vitreum sp. nov.
Pl. 3, figs. 35a-c

Test planispiral with up to 15 chambers in the last whorl, lenticular in edge view with bluntly angular periphery, sutures nearly flush, translucent, crossed by short processes forming a row of shallow pits into which large pores open. These pores which angle outwards toward the periphery are seen to have their origin in a thread-like septal canal which is visible through the translucent wall. Chamber walls polished and finely pored, umbo glassy and non-pored, aperture consisting of a row of pores at the base of the apertural face.

Holotype from 62-99, Reg. No. G2147. Major diameter 0·34 mm, thickness 0·17 mm.

This species occurs in small numbers at nine stations in the Lower Bay or just outside the Heads. Its sutural characteristics combined with its general morphology are distinctive. The largest specimen found, having several chambers missing, was 0·70 mm in maximum diameter.

Distribution: 58, 60-62, 67-68.

206. Elphidium articulatum (d'Orbigny) multicameratum subsp. nov.
Pl. 3, figs. 31a-b

Test planispiral with up to 17 chambers in the final whorl, periphery broadly rounded and somewhat lobulate (more so in smaller specimens), umbilicus depressed, chambers inflated, sutures depressed and crossed by short processes forming elliptical pits, wall finely porous and opaque, aperture consisting of a narrow slit at the base of the apertural face.

Holotype from 56-C9, Reg. No. G2143. Major diameter 0·68 mm, thickness 0·30 mm.

This subspecies has the general characteristics of *E. articulatum* but has many more chambers in the final whorl, up to 17 in comparison with 10. It was found at 12 stations scattered over the Survey, and was common at the shore stations of Altona Bay (5-C1) and the Barwon estuary (56-C9).

Distribution: 5, 19, 22-23, 26, 30, 33, 36, 39-40, 55-56 (C9), 58, 61.

207. Elphidium earlandi Cushman avalonense subsp. nov.
Pl. 3, figs. 32a-b.

Test small, planispiral, strongly compressed, periphery bluntly keeled, chambers inflated with finely-pored and translucent wall, up to 13 in the last whorl. Sutures depressed, crossed by 7-8 retral processes taking up from 0·3-0·5 the width of chambers, umbilicus depressed, aperture consisting of a few pores at the base of the apertural face.

Holotype from 26-C3, Reg. No. G2144. Major diameter 0·39 mm, thickness 0·13 mm.

This species combines the extreme compression of *E. macellum* with inflation of the anterior part of the chamber as in *E. advenum*. It is close to *E. earlandi* s. str. but differs in

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having more chambers in the final whorl, fewer retral processes and in being keeled throughout. The differences are not major, and it has therefore been given subspecific status. It was found at six stations in the SW. part of Port Phillip in addition to the type locality at Avalon Beach, Corio Bay.

Distribution: 26-28, 39, 49, 63, 68.

208. **Elphidium gunteri** Cole **corioense** subsp. nov.
Pl. 3, figs. 34a-b.

Test fairly small, planispiral with up to 14 chambers in the final whorl, sides slightly convex, periphery broadly rounded and becoming more angular and slightly lobulate in the later chambers which are somewhat inflated. Sutures depressed in the last 3-4 chambers, elsewhere flush, with very short retral processes forming an irregular row of rounded pits which lie anterior to the septum, which is seen as a pale band between the lumen of the previous chamber and the row of pits. Central area flush and marked by a group of rounded papillae which in some cases coalesce. Aperture consists of a row of small pores at the base of the apertural face.

Holotype from 39-313, Reg. No. G2146. Major diameter 0·36 mm, thickness 0·18 mm.

This form is close to *E. gunteri,* described from the Pliocene of Florida, but differs in the less regular sutural pits, more angular periphery on later chambers, slightly smaller average size and in the distinctive appearance caused by the edge of the septum showing through the transparent wall behind the row of pits. Specimens were found in 18 stations in Port Phillip and Bass Strait.

Distribution: 5, 9-10, 12, 16-17, 30-32, 38-40, 56, 58-60, 66, 68.

Subfamily NOTOROTALIINAE
Genus PARRELLINA Thalmann, 1951
209. **Parrellina verriculata** (Brady)

Polystomella verriculata Brady, 1879 etc. (1881), p. 66; 1884, p. 738, pl. lx, figs. 12a-b; Chapman 1909, p. 142, pl. 10, fig. 10.

Elphidioides verriculatus (Brady). Parr 1950, p. 374, pl. xv, fig. 17 (non *Elphidioides* Cushman 1945).

Rare juvenile specimens were found at seven stations in Bass Strait or just inside Port Phillip Heads. It is more commonly found in deeper water. Distribution: 56, 58-60, 66.

Genus NOTOROTALIA Finlay, 1930
210. **Notorotalia clathrata** (Brady)

Rotalia clathrata Brady, 1884, p. 709, pl. cvii, fig. 8.
Notorotalia clathrata (Brady). Finlay 1939 etc. (1939), p. 517; Parr 1950, p. 374.

This species, described from Bass Strait, was fairly common in material from Lower Bay and Bass Strait stations.

Distribution: 56, 58-59, 61-62, 66-69.

Superfamily GLOBIGERINACEA
Family GLOBOROTALIDAE
Subfamily GLOBOROTALIINAE
Genus GLOBOROTALIA Cushman, 1937
211. **Globorotalia hirsuta** (d'Orbigny)

Rotalina hirsuta d'Orbigny, 1839B, p. 131, pl. 1, figs. 37-39.
Globorotalia hirsuta (d'Orbigny). Parker 1962, p. 238, pl. 5, fig. 12.

Occurs generally in Bass Strait and Lower Bay stations.

Distribution: 50, 56, 58-62, 66, 68-69.

212. **Globorotalia truncatulinoides** (d'Orbigny)

Rotalina truncatulinoides d'Orbigny, 1839B, p. 132, pl. ii, figs. 25-27.
Globorotalia truncatulinoides (d'Orbigny). Cushman 1918 etc. (1931), p. 87, pl. 17, figs. 4a-c; Parr 1950, p. 367.

Occurs generally in Bass Strait and Lower Bay stations and as far N. as Area 43. Specimens are small but characteristic.

Distribution: 43, 50, 56, 58-62, 66, 68.

213. **Globorotalia inflata** (d'Orbigny)

Globigerina inflata d'Orbigny, 1839B, p. 134, pl. ii, figs. 7-9; Parr 1945, p. 215; 1950, p. 366.
Globorotalia inflata (d'Orbigny). Albani 1968, p. 113; 1970, p. 73 (Table 1).

Rather more common than the other two species of the genus and having the same general distribution.

Distribution: 42-43, 50, 56, 58-62, 66, 68-69.

Family GLOBIGERINIDAE
Subfamily GLOBIGERININAE
Genus GLOBIGERINA d'Orbigny, 1826

214. **Globigerina bulloides** d'Orbigny

Globigerina bulloides d'Orbigny, 1826, p. 277,
Modèles No. 17; Parr 1945, p. 215; 1950, p. 365;
Albani 1968, p. 114.

Present in small numbers in Bass Strait and
Lower Bay stations.
Distribution: 43, 50, 56, 58-63, 66, 68.

Genus GLOBIGERINOIDES Cushman, 1927

215. **Globigerinoides trilobus** (Reuss)

Globigerina triloba Reuss, 1850, p. 374, pl. 47, figs.
11a-c.
Globigerinoides trilobus (Reuss) forma typica. Bol-
tovskoy 1969, p. 252, pl. 2, fig. 9.

Present in small numbers in Bass Strait and
Lower Bay stations.
Distribution: 43, 50, 56, 58-61, 66, 68.

216. **Globigerinoides ruber** (d'Orbigny)

Globigerina rubra d'Orbigny, 1839A, p. 82, pl. iv,
figs. 12-14.
Globigerinoides rubra (d'Orbigny). Cushman 1927,
p. 87.
G. ruber (d'Orbigny). Parr 1945, p. 215; Albani 1968,
p. 114.

Rare specimens were found at five stations
in Bass Strait and the Lower Bay.
Distribution: 43, 56, 58, 60, 66.

Subfamily ORBULININAE
Genus ORBULINA d'Orbigny, 1839A

217. **Orbulina universa** d'Orbigny

Orbulina universa d'Orbigny, 1839A, p. 3, pl. i,
fig. 1; Parr 1945, p. 215; 1950, p. 366; Albani
1968, p. 115.

Common in Bass Strait material and occur-
ring also in the Lower Bay. Specimens were
small and many apparent juveniles were pres-
ent.
Distribution: 43, 50, 56, 58-62, 66, 68-69.

Superfamily ORBITOIDACEA
Family GLABRATELLIDAE
Genus GLABRATELLA Dorreen, 1948

218. **Glabratella pulvinata** (Brady)

Discorbina pulvinata Brady, 1884, p. 650, pl. lxxxix,
figs. 8-9.
Discorbis pulvinatus (Brady). Parr 1945, p. 210.

Glabratella pulvinata (Brady). Loeblich and Tappan
1964, p. C589, figs. 464, 2a-c.

Fairly common at Barwon Heads and found
in other Bass Strait and Lower Bay stations.
Distribution: 50, 56, 58, 60-61, 66, 68.

219. **Glabratella australensis** (Heron-Allen and Earland)

Discorbis australensis Heron-Allen and Earland, 1932,
p. 416; Parr 1945, p. 209.
Glabratella australensis (H-A. and E.). Albani 1968,
p. 110.

Fairly common in Bass Strait and the Lower
Bay. Recorded from Bass Strait by Brady (as
Discorbina pileolus).
Distribution: 43, 50, 56, 58-61, 66-69.

220. **Glabratella patelliformis** (Brady)

Discorbina patelliformis Brady, 1884, p. 647, pl.
lxxxix, figs. 1a-c.
Discorbis patelliformis (Brady). Parr 1945, p. 209.
Glabratella patelliformis (Brady). Albani 1968, p.
110, pl. 9, figs. 11, 15.

This species is of fairly rare occurrence at
Barwon Heads and at two stations in the Lower
Bay. It has a wide distribution in the Australian
region.
Distribution: 50, 56, 61.

Genus ANGULODISCORBIS Uchio, 1953

221. **Angulodiscorbis pyramidalis** (Heron-Allen and Earland)

Discorbis pyramidalis Heron-Allen and Earland,
1924A, p. 634, pl. 37, figs. 56-61.

Rare specimens from Bass Strait and Lower
Bay stations are referred to this species with
some degree of doubt. Two large specimens
from Area 50 show the concave faces and sharp
angles which characterise this species, though
not so markedly as in tropical specimens with
which they were compared. Smaller specimens
tend to have rounded angles, though still squar-
ish in cross-section. A larger series of speci-
mens might resolve this point.
Distribution: 50, 56, 58, 60-61, 66, 68.

Genus HERONALLENIA Chapman and Parr,
1931

222. **Heronallenia lingulata** (Burrows and Holland)

Discorbina lingulata Burrows and Holland, 1895, p.
297, pl. vii, figs. 33a-c.

Heronallenia lingulata (B. and H.). Chapman and Parr 1931, p. 236, pl. ix, fig. 6; Parr 1945, p. 211.

Frequent at Barwon Heads and occurring in small numbers in other Bass Strait and Lower Bay stations.

Distribution: 43, 50, 56, 58-59, 61, 66, 68.

223. **Heronallenia translucens** Parr

Heronallenia translucens Parr, 1945, p. 211, pl. ix, figs. 15-16.

Frequent at Barwon Heads, with a limited distribution at other Bass Strait and Lower Bay stations. So far this species appears to be confined to Victorian coastal waters.

Distribution: 56, 58, 61, 66, 68.

Family ROSALINIDAE
Genus ROSALINA d'Orbigny, 1826

224. **Rosalina australis** Parr

Discorbis australis Parr, 1932, p. 227, pl. 22, figs. 31a-c; 1945, p. 209.
Rosalina australis (Parr). Albani 1968, p. 109, pl. 9, fig. 8.

Common in Bass Strait stations and in the Lower Bay.

Distribution: 42, 50-51, 56, 58-62, 66-69.

225. **Rosalina anglica** (Cushman)

Discorbis globularis (d'Orbigny) var. *anglica* Cushman, 1918 etc. (1931), p. 23, pl. 4, figs. 10a-c; Parr 1945, p. 209, pl. ix, figs. 11a-c.
Rosalina anglica (Cushman). Albani, 1968, p. 109, pl. 9, fig. 4.

Occurs in a number of Bass Strait and Lower Bay stations, but is nowhere common.

Distribution: 50, 56, 58-61, 63, 68.

226. **Rosalina kennedyi** (Parr)

Discorbis kennedyi Parr, 1945, p. 209, pl. ix, figs. 12a-b, 13a-b.

Not uncommon in Bass Strait beach stations, with a few specimens from the Lower Bay. The apertural flap is not well developed in this species, but can be seen as a narrow imperforate lip arching over the aperture from the umbilicus to about halfway toward the periphery. It is clearly not a *Discorbis* in the present restricted sense, and appears to be best placed in *Rosalina*.

Distribution: 56, 58-59, 61, 68.

227. **Rosalina pustulata** (Heron-Allen and Earland)

Discorbina pustulata Heron-Allen and Earland, 1913, p. 129, pl. 12, figs. 5-7; Sidebottom 1918, p. 255, pl. vi, figs. 9-11.

Two specimens were found in Areas 56 and 68. They are closer to Sidebottom's figure than to the original, the pustules on the dorsal side being closely spaced except toward the edges. However, the difference does not appear to warrant separation. Sidebottom's specimens were from the E. coast of Australia.

228. **Rosalina coronata** (Heron-Allen and Earland)

Discorbis coronata Heron-Allen and Earland, 1932, p. 416, pl. xiv, figs. 25-30.
Discorbis coronatus (Heron-Allen and Earland). Parr 1950, p. 355, pl. xiv, fig. 3.

Six specimens from Barwon Heads and the Lower Bay correspond with the description of this species. Parr recorded it from off Tasmania, the original record being from the Falkland Is.

Distribution: 50, 56, 68.

229. **Rosalina bertheloti** d'Orbigny

Rosalina bertheloti d'Orbigny, 1839B, p. 135, pl. i, figs. 28-30; Albani 1968, p. 109, pl. 8, figs. 19-20, 25-26.
Discorbis bertheloti (d'Orbigny). Parr 1945, p. 210; 1950, p. 355.

Specimens were found in eleven Bass Strait and Lower Bay stations. They are similar to Albani's figs. 25-26.

Distribution: 50, 56, 58-59, 61-62, 66-68.

230. **Rosalina parri** sp. nov.
Pl. 3, figs. 36a-c

Discorbis williamsoni Chapman and Parr ms. Parr 1932, p. 226, pl. xxi, fig. 25; 1945, p. 210, pl. x, figs. 3a-b (non *Discorbis williamsoni* Chapman and Parr, 1937, p. 105, pl. 21, fig. 25).

Test sub-circular to elliptical, spiral side low-convex with strongly arcuate chambers, usually three in the last whorl, sutures broad, limbate and flush, periphery sharply keeled, not lobulate. Umbilical side slightly concave with deep, stellate open umbilicus, chambers sub-triangular, surface radially-grooved in varying degree, interspaces forming low ridges ending in clear

mamillate protuberances at the umbilicus, apertures on both sides of a broad apertural flap. Surface highly polished, finely and closely perforate on spiral side, clear and sparsely perforate on umbilical side.

Holotype: Parr's specimen fig. 3a-b (1945). *Plesiotype* (illustrated) from 58-C7, Reg. No. G2148.

Chapman and Parr's rather poor figure of *"Discorbis" williamsoni* shows a test with lobulate periphery and 5·5 chambers in the last whorl, which agrees with Williamson's figure of *Rotalina nitida* (re-named by Chapman and Parr) and with British specimens from the Pliocene of St. Erth, Cornwall. It also agrees with specimens identified in the present work as *Rosalina williamsoni* (C. and P.) but considered to be distinct from the present form.

R. parri differs from *R. williamsoni* in having fewer and more arcuate chambers in the final whorl, broad limbate sutures, entire and non-lobulate periphery and radial grooving on the umbilical side, the latter feature being evident only in the larger specimens. Parr's fig. 3 shows these features well, except for radial grooving which is not present in all specimens.
Distribution: 31, 50, 58-59, 62, 66, 68.

231. **Rosalina williamsoni** (Chapman and Parr)

Rotalina nitida Williamson, 1858 (non *R. nitida* Reuss, 1844).
Discorbis williamsoni Chapman and Parr, 1937, p. 105, pl. xxi, fig. 25.

Specimens from the Lower Bay and Bass Strait have 4-5·5 chambers in the last whorl, a lobulate periphery, narrow or slightly depressed sutures and a stellate umbilicus with clear mammillar blebs at the chamber apices, and as noted above are similar to British specimens of this species. The generic characters are those of *Rosalina* rather than of *Discorbis* in the present restricted sense.
Distribution: 50, 56, 59, 61, 68.

Genus TRETOMPHALUS Moebius, 1880

There is considerable doubt as to the status of this genus (Todd 1971) and its relationship with *Cymbaloporetta* Cushman. Two forms

occur in the present collections which are referable to described species, and it appears preferable to continue to refer them to *Tretomphalus* until the biological relationships in this group are more clearly established.

232. **Tretomphalus concinnus** (Brady)

Discorbina concinna Brady, 1884, p. 646, pl. xl, figs. 7-8.
Cymbalopora bulloides d'Orbigny. Earland 1902, pp. 309-321, pl. 16.
Tretomphalus concinnus (Brady). Cushman 1934, p. 96.
Tretomphalus bulloides (d'Orbigny) *concinnus* form, Todd 1971, p. 166, pl. 1, figs. 1-2, 4.

Specimens with float chambers were not uncommon in Bass Strait beach sands and were taken by the writer in a plankton haul in Swan Bay (49). They were compared with specimens from a portion of Earland's original material from Corny Point, S. Aust. and are considered to be conspecific. Specimens of the *Rosalina*-stage were found in both Bass Strait and Lower Bay stations.
Distribution: 49, 56, 58, 62.

233. **Tretomphalus planus** Cushman

Tretomphalus planus Cushman, 1934, p. 94, pl. 11, fig. 11, pl. 12, figs. 18-22.
Tretomphalus bulloides (d'Orbigny) *planus* form, Todd 1971, p. 166.

Specimens with float chambers were found in Bass Strait shore sands, together with the acervuline early stage which was also found in Lower Bay dredgings. One specimen with float chamber was taken in the plankton haul referred to above. The acervuline stage showed four chambers in the latest whorl, as did the pelagic specimens after removal of the float chamber.

It may be noted that, in spite of Earland's assertion that his Corny Point specimens were all of the 'Discorbine' variety (1902, p. 318), the material in fact contains a small proportion of individuals having an acervuline early stage and considered to be referable to the present species. In a random count of 380 specimens, five were acervuline, approximately 1·3%. They differ from the 'Discorbine' form in the reduced size of the *Rosalina*-stage and

in the subsequent development of one or more rings of acervuline chambers, but are otherwise very similar but slightly larger.

One of these specimens was of some interest in that the dorsal view shows two *Rosalina*-stages side by side, surrounded by rings of acervuline chambers, presumably caused by the accidental coalescence of two individuals at an early stage in development.

The presence of these acervuline specimens in what amounts to a reproductive swarm of *T. concinnus* gives support to Todd's view that they may be forms of a single species, considering the apparent simultaneity of their reaching the reproductive stage.

Distribution: 50, 56, 58-61, 68.

Family CIBICIDIDAE
Subfamily PLANULININAE
Genus PLANULINA d'Orbigny, 1826

234. **Planulina bassensis** sp. nov.
Pl. 3, figs. 37a-c

Test sub-circular, concavo-convex, evolute on the dorsal side, partially evolute on the ventral side. Dorsal side convex with slightly depressed and recurved sutures, limbate in early chambers, wall finely pored with scattered larger pores in later chambers. Ventral side concave with depressed umbilicus, chamber walls inflated and coarsely pored, sutures limbate and recurved, periphery bluntly keeled. Aperture interio-marginal extra-umbilical umbilical, formed by a narrow non-pored flap. Wall structure hyaline, radial and bilamellar. *Holotype* from 56-C8, Reg. No. G2149.

Greatest diameter 0·38 mm, thickness 0·12 mm.

Specimens were common at Barwon Heads and were found at nine other Bass Strait and Lower Bay stations. This small *Planulina* does not appear to correspond with any described species. Some specimens have a tendency toward irregularity in the last one or two chambers.

Distribution: 43, 50, 56, 58-62, 66.

Subfamily CIBICIDINAE
Genus CIBICIDES de Montfort, 1808

235. **Cibicides lobatulus** (Walker and Jacob)

Nautilus lobatulus Walker and Jacob, 1798, p. 39, pl. xii, fig. 36.
Cibicides lobatulus (Walker and Jacob). Cushman 1918 etc. (1931), p. 118, pl. 21, fig. 3.

Four specimens were found in Area 62 which closely match N. Atlantic specimens from Dog's Bay, Galway. It was not found elsewhere in the present collections.

236. **Cibicides mayori** (Cushman)

Truncatulina mayori Cushman, 1924, p. 39, pl. 12, figs. 3-4.
Cibicides mayori (Cushman). Cushman, Todd and Post 1954, p. 371, pl. 91, figs. 29-30; Todd 1965, p. 53, pl. 22, fig. 7.

Typical specimens of this flattened, irregular and sharply-keeled species were found at Barwon Heads, three stations in the Lower Bay and two in Geelong Outer Harbour.

Distribution: 27-28, 56, 58, 62, 68.

237. **Cibicides** sp. A
Pl. 3, figs. 38a-c, 39-40.

A common species in Bass Strait and Lower Bay stations assumes a variety of forms conforming to the diagnosis of more than one genus. The basic *Cibicides*-form is small (diam. 0·5 mm), planoconvex, umbilical side involute, high-domed and finely pored; the spiral side is evolute, flat and coarsely pored with a bluntly-keeled periphery. Aperture is arched and dorso-peripheral. Wall structure is hyaline, radial and bilamellar.

Some specimens continue with a regular *Cibicides*-like development, the later chambers on the umbilical side becoming more coarsely pored. Others have the last few chambers in a spiral series but irregular in shape, while others again develop biserially, approximating to *Dyocibicides*. Occasional specimens exhibit staggered uniserial growth with a terminal and areal lipped aperture.

The conspecificity of these forms is assumed, based on the similarity of the early spiral portion in each case, but needs confirmation through studies of the living organism. In view

of the doubts expressed by Nyholm (1961) and others as to the validity of some of the wild-growing genera of the Cibicidinae it appears best to leave identification open.

This may be the species referred by Parr (1945, p. 214) to *C. lobatulus* and mentioned as showing *Dyocibicides* and *Rectocibicides* forms. However, it is certainly not *C. lobatulus* as found in British waters.

Figured specimens from 58-C7, Reg. No. G2150. Distribution: 38, 43, 49-51, 56, 58-62, 66-69.

238. Cibicides phillipensis sp. nov.
Pl. 4, figs. 41a-c

Test trochospiral, plano-convex, bluntly-keeled and somewhat lobulate in the later chambers. Involute side is strongly convex and umbilicate with about seven chambers in the final whorl, wall coarsely perforate, sutures slightly depressed. Spiral side is flat, all chambers visible, sutures limbate and flush, wall coarsely perforate. Aperture is a short arched slit with a narrow imperforate lip, reaching periphery on the involute side, together with a very narrow slit along the spiral suture which is visible only in the last chamber. Wall structure hyaline, radial and bilamellar.

Holotype from 69-97, Reg. No. G2151. Greatest diameter 0·68 mm, thickness 0·42 mm. This species is distinguished from the foregoing by its consistently coarse-pored wall on the involute side, its generally larger size and its regular form. It is fairly common in Bass Strait and Lower Bay stations, and does not correspond with any described form known to the writer.

Distribution: 50, 56, 58-62, 67-69.

239. Cibicides wattsi sp. nov.
Pl. 4, figs. 42a-c

Test trochospiral, planoconvex to unequally biconvex, periphery bluntly-keeled, not lobulate. Umbilical side partially evolute showing the proloculus and first whorl, polished and finely perforate, sutures slightly depressed. Spiral side evolute, coarsely perforate and roughened by exogenous shell-growth, sutures

limbate, slightly raised and strongly recurved. Aperture peripheral, a small arched slit with a slight lip. Wall hyaline, radial and bilamellar. *Holotype* from 60-215, Reg. No. G2152. Greatest diameter 0·40 mm, thickness 0·15 mm.

This small and regularly-formed species is notable in being partially evolute on the umbilical side, but otherwise is a typical *Cibicides*, and does not appear to have been previously described. The specific name is given in honour of the first local worker in the Foraminiferida, Mr. H. Watts.

Distribution: 43, 50, 56, 58, 60-61, 66, 68-69.

Family PLANORBULINIDAE
Genus PLANORBULINA d'Orbigny, 1826

240. Planorbulina mediterranensis d'Orbigny

Planorbulina mediterranensis d'Orbigny, 1826, p. 280, No. 2, pl. 14, figs. 4-6; Parr 1945, p. 214; Albani 1968, p. 116, pl. 10, figs. 12, 16.

Common in Bass Strait and Lower Bay stations. Specimens compare well with Mediterrean specimens and lack the size, colour and development of exogenous ridges and nodes on the early chambers seen in *P. rubra* from the S. Aust. coast.

Distribution: 31, 50, 56, 58-62, 68-69.

241. Planorbulina sp. A
Pl. 4, figs. 43a-b

Test adherent, at first trochospiral, later irregular and spreading, chambers broad, low and meandering, wall in early chambers apparently pseudo-chitinous, later calcareous, coarsely perforate. Apertures peripheral and multiple, up to four per chamber, with a projecting lip and arranged in line along the leading edge of the chamber.

Figured specimen from 5-165, Reg. No. G2153. Length 1·1 mm.

This form differs from the common *P. mediterranensis* of this collection in its broad and low chamber shape and in its multiple apertures. It has not been identified with any described species, but as only one specimen was found it is recorded by open nomenclature.

flation and irregularity in the addition of chambers. The stitch-like Wiesner canals can be seen in most specimens, but are confined to the distal end of the suture of the final chamber. The septal pores of *D. polymorphinoides* were not observed in any specimens. Fig. 2 shows some of the observed variations in external form.
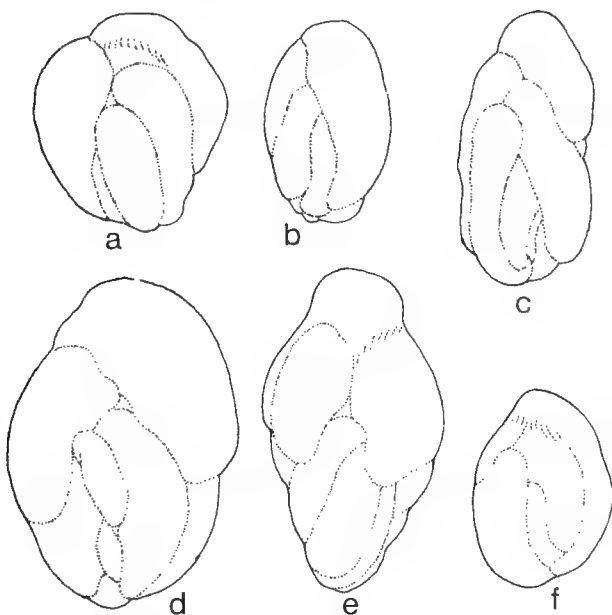
Fig. 2—*Delosina complexa* (Sidebottom) s.l. a-e specimens from slide by W. J. Parr, Barwon Heads; f, Survey coll. stat. C8. All x 42.

As the assemblage of specimens has every appearance of representing a single population, it appears best to record it under Sidebottom's original species *complexa* s.l. though many specimens would not conform to Earland's restricted description of this species. It apparently has a seasonal occurrence at Barwon Heads, as it has been found in only one of the collections made by the writer at this locality. Judging by Parr's slide of 39 specimens, it can occur in considerable numbers on occasion.

Family CASSIDULINIDAE
Genus CASSIDULINA d'Orbigny, 1839

247. **Cassidulina carinata** Silvestri

Cassidulina laevigata d'Orbigny var. *carinata* Silvestri, 1896, p. 104, pl. ii, fig. 10.

Cassidulina carinata Silvestri. Todd 1965, p. 40, pl. 17, fig. 4; Eade 1967, p. 429, fig. 2, Nos. 5-9.

Small, compressed and sharply-keeled specimens with four pairs of chambers in the last whorl are referred to this cosmopolitan species. They were rare in Bass Strait and Lower Bay stations, with one occurrence in the W. Bay. Distribution: 30, 56, 58, 61, 68.

248. **Cassidulina laevigata** d'Orbigny

Cassidulina laevigata d'Orbigny, 1826, p. 282, pl. xv, figs. 4-5; Parr 1945, p. 207.

Small, sub-circular, compressed specimens with angular but not keeled periphery are referred to this species which was recorded by Parr from Barwon Heads. Rare in Bass Strait and Lower Bay stations. Distribution: 50, 56, 58, 68.

249. **Cassidulina delicata** Cushman

Cassidulina delicata Cushman, 1927, p. 168, pl. 6, fig. 5; Parr 1950, p. 343.

Small, sub-circular specimens with broadly rounded periphery and elongated narrow aperture at the base of the apertural face are referred to this species, which was recorded by Parr from E. Bass Strait. Specimens occurred rarely in four stations from Bass Strait and the Lower Bay. Distribution: 50, 58, 68.

250. **Cassidulina** sp. A
Pl. 4, figs. 44a-b

Test sub-circular, inflated, periphery sharply-keeled and twisted, chambers developing lobate extensions toward the centre of the test which obscure early chambers, aperture U-shaped, partly filled by an internal toothplate. *Figured specimen* from 56-C8, Reg. No. G2154. Greatest diameter 0·32 mm, thickness 0·18 mm.

Only one specimen was found, which has not been identified with any described species. Its distinctive characteristics are the twisted carinate periphery and the lobate chamber extensions. It is described and figured for the record by open nomenclature.

251. **Cassidulina inflata** Le Roy

Cassidulina inflata Le Roy, 1944, p. 37, pl. 4, figs. 30-31.

Two specimens are very close to Le Roy's figure, particularly in the angular hood-like shape of the apertural face of the final chamber and the triangular toothplate which partially occludes the aperture.

Distribution: 29, 42.

252. **Cassidulina victoriensis** sp. nov.
Pl. 4, figs. 45a-c

Test sub-oval, compressed, periphery rounded and slightly lobulate, four pairs of chambers in the last whorl, sutures slightly depressed and barely visible, aperture narrowly triangular and open with an internal toothplate, in a rounded depression in the apertural face. Wall finely perforate and polished.

Holotype from 56-C8, Reg. No. G2155. Greatest diameter 0·40 mm, thickness 0·13 mm.

This species is distinguished by its compression and open triangular aperture, and does not appear to correspond to any described species.

Distribution: 30, 50, 56, 68.

Genus GLOBOCASSIDULINA Voloshinova, 1960
253. **Globocassidulina subglobosa** (Brady)

Cassidulina subglobosa Brady, 1879 etc. (1881), p. 60; 1884, p. 430, pl. liv, fig. 17; Parr 1945, p. 207; 1950, p. 343.
Globocassidulina subglobosa (Brady). Eade 1967, p. 437.

This is the commonest cassidulinid in Port Phillip and adjacent waters, though rare N. of the Lower Bay. Specimens are similar to Brady's figure, with slight elongation of the ultimate chamber and a simple loop-shaped aperture without basal prolongations.

Distribution: 33, 38, 43, 50, 56, 58-62, 66-68.

254. **Globocassidulina minuta**? (Cushman)

Cassidulina minuta? Cushman, 1933; p. 92, pl. 10, figs. 3a-c; Todd 1965, p. 43, pl. 17, fig. 3.
Globocassidulina minuta (Cushman). Eade 1967, p. 437, fig. 5, Nos. 2-3.

Specimens matching Eade's figures were found in three Bass Strait and Lower Bay stations. Whether they represent Cushman's species is open to some doubt. His original description states that the aperture is "elongate, 4-5 times as long as broad", and his fig. 3b shows only a slit following the junction of the last and penultimate chambers. Todd, working with the same Pacific material, states that the outer end of the apertural slit continues into a loop-shaped opening extending into the apertural face, but her fig. 3b, apparently reproduced from Cushman, does not show this character. This apparent contradiction cannot be resolved from the present material, and the question is accordingly left open.

Distribution: 50, 56, 68.

Genus EHRENBERGINA Reuss, 1850
255. **Ehrenbergina aspinosa** Parr

Ehrenbergina pacifica Cushman var. *aspinosa* Parr, 1950, p. 345, pl. xiii, figs. 1-2.

Specimens were found at 11 Bass Strait and Lower Bay stations. Nearly all were dorsally smooth with narrow limbate sutures, only two showing some ridging of the sutures in the early chambers. All were lacking in marginal spines, the sharply-keeled edges showing no signs of having originally had spines which were subsequently lost by attrition.

Eade (1967, p. 444) suggests that raised sutures on the dorsal side are characteristic of this species, but Parr did not mention this in his description, and his figure shows raised sutures on the early chambers only. A slide from Parr's collection, labelled as from 35 km E. of Narrabeen, N.S.W., 145 m, contains seven specimens in which all the dorsal sutures are raised, sharp-edged and frill-like, and the periphery is spined. These were named by Parr (incorrectly in the writer's opinion) as *E. pacifica* Cushman.

They appear to correspond with the Pacific specimens studied by Eade and referred to *E. aspinosa*. The present specimens appear to be distinct and are considered to represent more correctly the form described and figured by Parr.

Distribution: 50, 56, 58, 61, 66, 68-69.

256. **Ehrenbergina** cf. **glabra** Heron-Allen and Earland

cf. *Ehrenbergina hystrix* Brady var. *glabra* Heron-Allen and Earland, 1922, p. 140, pl. v, figs. 1-6, 11.
cf. *E. glabra* Heron-Allen and Earland. Chapman and Parr 1937, p. 84; Parr 1950, p. 344; Eade 1967, p. 445.

One specimen from Barwon Heads (56-C8) has the smoothly-rounded ventral area characteristic of this species, but is lacking in peripheral spines, the marginal keel showing no signs of having had spines or even angular chamber extensions. It may fall within the limits of variation of *E. glabra* but in the lack of a series for comparison is recorded by open nomenclature.

Superfamily NONIONACEA
Family NONIONIDAE
Subfamily NONIONINAE
Genus NONION de Montfort, 1808

257. **Nonion depressulus** (Walker and Jacob)

Nautilus depressulus Walker and Jacob, 1798, p. 641, pl. xiv, fig. 23.
Nonion depressulus (W. and J.). Parr 1945, p. 215; Murray 1965, p. 148, pl. 25, figs. 6-7, pl. 26, figs. 7-8.

Specimens were common in the Barwon Estuary (56-C9) and in Swan Bay, and occurred rarely in the W. Bay. The wall structure is granular, finely pored and translucent. Specimens compared well with others from Broadstairs on the Kentish coast (from which the species was described). Locally the species favours shallow, muddy, stillwater conditions, and is tolerant of lowered salinity.
Distribution: 5, 31, 49, 56.

Genus ASTRONONION Cushman and Edwards, 1937

258. **Astrononion australe** Cushman and Edwards

Astrononion australe Cushman and Edwards, 1937, p. 83, pl. 3, figs. 13-14.

Rare at Barwon Heads and in Areas 58 and 59. Specimens are somewhat smaller but otherwise compare well with others from the type sample (Lower Beds, Muddy Cr., Vict.). Occurrence in stations just within Port Phillip

Heads where Tertiary contamination is unlikely is considered to justify recording these specimens as Holocene.

259. **Astrononion novozealandicus** Cushman and Edwards

Astrononion novozealandicum Cushman and Edwards, 1937, p. 35, pl. 3, figs. 18a-b.

This species, characterised by its narrow tubular sutural flaps, occurred in small numbers in ten Bass Strait and Lower Bay stations and in two localities in the W. Bay. Specimens compared well with others from off New Zealand.
Distribution: 5, 16, 50, 56, 58-61, 66, 68-69.

Genus FLORILUS de Montfort, 1808

260. **Florilus grateloupi** (d'Orbigny)

Nonionina grateloupi d'Orbigny, 1826, p. 24, No. 19; 1839A, p. 46, pl. 6, figs. 6-7.

Rare specimens from five stations within Port Phillip agree with a Cuban specimen of *F. grateloupi*. The species has been recorded from the E. Pacific and from the Falkland Is.
Distribution: 5, 13, 28, 49, 61.

261. **Florilus scapha** (Fichtel and Moll)

Nautilus scapha Fichtel and Moll, 1798, p. 105, pl. xix, figs. d, f.
Nonion scapha (F. and M.). Cushman 1939, p. 20, pl. 5, figs. 18-21; Parr 1945, p. 215.

Common at Barwon Heads and found also in the Lower Bay and at seven stations in the W. Bay. Specimens are small but otherwise characteristic.
Distribution: 6, 16-18, 26-28, 49, 56, 58, 61, 68.

Genus NONIONELLA Cushman, 1926

262. **Nonionella pulchella** Hada
Pl. 4, figs. 46a-c

Nonionella pulchella Hada, 1931, p. 120, fig. 79 (in text).

Two specimens having the characteristic cuspate umbilical lobe were found in Area 68.
Figured specimen from 68-156, Reg. No. G2156. Length 0·28 mm, breadth 0·19 mm, thickness 0·12 mm.

263. **Nonionella aff. parri**

aff. *Nonionella parri* Cushman, 1936A, p. 89, pl. 13, figs. 17a-c.

Rare specimens from four stations in the Lower Bay and in Area 13 have the assymetrical shape, sub-acute periphery, limbate sutures and umbilical ornament of this species, but are much smaller, about 0·25 mm in length. From the material available, identification with Cushman's species, described from Holocene shore sand, New Zealand, is uncertain.

Distribution: 13, 50, 59, 68.

264. **Nonionella vortex** sp. nov.

Pl. 4, figs. 47a-c

Test sub-circular, inequilaterally planispiral, compressed, parallel-sided, with up to 13 chambers in the last whorl. Chambers narrow and strongly curved, the last 3-4 increasingly curved toward the umbilicus. Sutures limbate and raised in early chambers, depressed in later chambers. Umbilicus slightly depressed and finely papillate, periphery rounded, aperture obscure, apparently basal.

Holotype from 68-155, Reg. No. G2157. Greatest diameter 0·27 mm, thickness 0·08 mm.

The nearest described species appears to be *N. cockfieldensis* Cushman and Ellisor from the Eocene of Texas. *N. vortex* differs in having more chambers in the final whorl, a broadly rounded periphery and in being more or less parallel-sided rather than increasing in thickness in later chambers. Only two specimens were found at station 155, but the characters appear sufficiently distinctive to justify description as new.

Genus PULLENIA Parker and Jones, 1862

265. **Pullenia bulloides** (d'Orbigny)

Nonionina bulloides d'Orbigny, 1846, p. 107, pl. v, figs. 8-10.
Pullenia bulloides (d'Orbigny). Cushman and Todd 1943, p. 13, pl. 2, figs. 15-18.

Small but characteristic specimens were found at four stations in Areas 50 and 58 near the entrance to Port Phillip.

266. **Pullenia quinqueloba** (Reuss)

Nonionina quinqueloba Reuss, 1851, p. 71, pl. 5, fig. 31.
Pullenia quinqueloba (Reuss). Cushman and Todd 1943, p. 10, pl. 2, fig. 5, pl. 3, fig. 8.

Specimens with five chambers in the final whorl and a slightly lobulate periphery, somewhat angular but rounded in edge view, are referred to this cosmopolitan species. They were found at Barwon Heads and in Areas 58, 61 and 68.

Family ALABAMINIDAE
Genus GYROIDINA d'Orbigny, 1826

267. **Gyroidina soldanii** d'Orbigny

Gyroidina soldanii d'Orbigny, 1826, p. 278, No. 5; Parr 1950, p. 360.

Specimens were small but have the morphological characters of this species, including a slit-like aperture confined to the middle of the apertural face and a supplementary aperture below the umbilical flap. They occurred rarely in eight Bass Strait and Lower Bay stations.

Distribution: 50, 56, 58-60, 62, 66, 69.

Genus SVRATKINA Pokorny, 1956

268. **Svratkina australiensis** (Chapman, Parr and Collins)

Discorbis tuberculata Balkwill and Wright var. *australiensis* Chapman, Parr and Collins 1934, p. 563, pl. viii, figs. 9a-c.
Svratkina australiensis (C. P. and C.). Pokorný, 1956, p. 257.

This species was described from the Balcombian (Mid. Miocene) of Balcombe Bay on the SE. coast of Port Phillip, but was also recorded by the authors as a Holocene species from Williamstown at the N. end of Port Phillip. In the present collections it occurs rarely at eight stations in the Lower Bay and Bass Strait, and was not found N. of Areas 50-55.

Distribution: 50, 55-56, 60-61, 63, 68.

Superfamily ANOMALINACEA
Family ANOMALINIDAE
Subfamily ANOMALININAE
Genus ANOMALINA d'Orbigny, 1826

269. **Anomalina tasmanica** Parr

Anomalina tasmanica Parr, 1950, p. 406, pl. xiv, figs. 4a-c.

Frequent at Barwon Heads (56-C8) and occurring also at other Lower Bay and Bass Strait stations.

Distribution: 50-51, 56, 58-61, 66, 68-69.

Genus ANOMALINOIDES Brotzen, 1942
270. **Anomalinoides nonionoides** (Parr)

Anomalina nonionoides Parr, 1932, p. 231, pl. xxii, fig. 38; 1945, p. 214; 1950, p. 362; Albani 1968, p. 117, pl. 10, fig. 11.

Specimens were not uncommon in Bass Strait and Lower Bay stations. They are generally smaller than N.S.W. specimens, but are considered to be conspecific. In this species the aperture is not confined to the periphery, but continues along the base of the chamber on the spiral side, requiring transfer to *Anomalinoides*. This feature is clearly seen in specimens from Parr's type sample, from Narrabeen, N.S.W.

Distribution: 43, 50, 56, 58, 60-62, 66, 68.

Genus KARRERIA Rzehak, 1891
271. **Karreria maoria** (Finlay)

Vagocibicides maoria Finlay, 1939 etc. (1939), p. 326, pl. 29, figs. 148-151, 158.
Dyocibicides laevis Parr, 1950, p. 365, pl. 15, figs. 8a-c.
Vagocibicides cf. *maoria* Finlay. Collins 1953, p. 103, pl. 1, figs. 9a-c.
V. maoria Finlay. Carter 1964, p. 90, pl. 6, figs. 116-120.
Karreria maoria (Finlay). Loeblich and Tappan 1964, p. C670, fig. 623, 19.

Single specimens were found at 50, 56, 59-60, 67, all in Bass Strait or the Lower Bay. The species is recorded from the Miocene of Gippsland and the Pleistocene of Port Fairy, both in Victoria.

Genus TRICHOHYALUS Loeblich and Tappan, 1953

272. **Trichohyalus australis** sp. nov.
Pl. 4, figs. 48a-c

Test trochospiral, compressed, with broadly rounded periphery. Spiral side convex with all chambers visible, eight in the last whorl, sutures slightly depressed and recurved, wall coarsely perforate. Umbilical side flat with depressed umbilical area obscured by pustular secondary growth, sutures depressed and recurved, later chambers inflated, wall finely perforate with scattered larger pores. Aperture obscure, presumably umbilical.

Holotype from 49-C6, Reg. No. 2158. Greatest diameter 0·35 mm, thickness 0·14 mm.

This southern form was first recorded as *T. tropicus* (Collins) (in Gill 1972, pp. 317-318) from an emerged shellbed of mid-Holocene age on the banks of a creek running into Corio Bay in Area 26. At the time it was noted that there were differences between it and the Barrier Reef species, and that it might represent a cool water modification.

On further consideration, these differences appear to justify specific separation. The broadly rounded periphery contrasts with the comparatively sharp edge of *T. tropicus*, the pustules are large and blister-like, and are confined to the umbilical area, reaching about halfway to the periphery, compared with the fine grained outgrowth which covers all but the last two chambers in that species.

Only two specimens were found is the present collections (Areas 5, 49). Until more specimens are available the wall structure is left undetermined.

Superfamily ROBERTINACEA

Three of the genera listed below have been shown by McGowran (1966a, 1966b) to be unrelated to this superfamily. *Ceratobuliminoides* is considered to be distinct from *Ceratobulimina* and probably related to *Heronallenia*. *Stomatorbina* and *Mississippina* are considered as probable constituents of a new family of unstated classification. The writer is unaware of any approach to finality in these matters, and accordingly has retained the species concerned in the classification adopted for the purposes of record only, without expressing any opinion on the suprageneric classification involved.

Family CERATOBULIMINIDAE
Subfamily CERATOBULIMININAE
Genus CERATOBULIMINOIDES Parr, 1950

273. **Ceratobuliminoides bassensis** Parr

Ceratobuliminoides bassensis Parr, 1950, p. 359, pl. xiv, figs. 12a-c.

Two specimens were found at Barwon Heads (56-C8).

Subfamily EPISTOMININAE
Genus MISSISSIPPINA Howe, 1930
274. **Mississippina pacifica** Parr

Mississippina pacifica Parr, 1950, p. 361, pl. xiv, figs. 17a-c.

Specimens were frequent at Barwon Heads (56-C8) and occurred also in Areas 50, 58, 62, and 68.

Genus STOMATORBINA Dorreen, 1948
275. **Stomatorbina concentrica** (Parker and Jones)

Pulvinulina concentrica Parker and Jones, in Brady 1864, p. 470, pl. xlviii, fig. 14.
Stomatorbina concentrica (P. and J.). Parr 1950, p. 360.

Two small specimens were found at Barwon Heads (56-C8). The species is more commonly found in deep water.

Subfamily ROBERTININAE
Genus ROBERTINA d'Orbigny, 1846
276. **Robertina tasmanica** Parr

Robertina tasmanica Parr, 1950, p. 369, pl. xv, figs. 10a-b, 11a-b.

One specimen from Barwon Heads (56-C8) has a somewhat tapering test similar to Parr's fig. 11. The species was described from off Tasmania.

Genus PSEUDOBULIMINA Earland, 1934
277. **Pseudobulimina chapmani** (Heron-Allen and Earland)

Bulimina chapmani Heron-Allen and Earland, 1922, p. 130, pl. iv, figs. 18-20.
Pseudobulimina chapmani (H. A. and E.). Earland 1934, p. 134, pl. vi, figs. 11-14; Parr 1950, p. 370.

Rare specimens occur at several Bass Strait and Lower Bay stations. They are small compared with Antarctic specimens, discoloured and with black-stained sutures, and have pre- sumably been transported from deeper water. Distribution: 50, 56, 59, 61, 66.

Genus UNGULATELLA Cushman, 1931
278. **Ungulatella pacifica** Cushman

Ungulatella pacifica Cushman. Cushman, 1931, p. 82, pl. 10, figs. 11-12; Collins 1958, p. 388, pl. iv, fig. 8.

One specimen was found at Barwon Heads (56-C8). Unfortunately it was lost during mounting for illustration. The presence of this rare tropical species is a further indication of the small warm-water element remaining in Victorian waters.

INCERTAE SEDIS

279. **'Webbinella bassensis'** Parr
Pl. 4, figs. 48-49

'Webbinella bassensis' Parr, 1945, p. 193, pl. vii, figs. 3a-c.

This organism was described from shore sand at Barwon Heads, and consists of a dome-shaped, agglutinated, hollow shell with a chitinous lining, having evidence of former attachment by a narrow inward-turning agglutinated rim surrounding a basal opening normally covered by a clear chitinous film. Parr's specimens were all detached, some showing a striated pattern on the surface of attachment, suggesting previous adherence to a fibrous substrate. His reference to *Webbinella* has since been invalidated by Loeblich and Tappan (1957) who showed that this genus is an attached polymorphinid, unrelated to agglu- tinated species of the same shape for which the genus *Hemisphaerammina* was erected.

No specimens have been found in any of the collections made by the writer at the type locality, but both attached and detached specimens were not uncommon at station C9 in the estuarine section of the Barwon River, an environment of mud-flats and mangroves. The attached specimens are cemented to hard surfaces such as sand grains, small molluscan shells and shell fragments, but the evidence of Parr's specimens suggests alternative attach- ment to algae, mangrove roots, etc.

Specimens were at first identified as *Hemisphaerammina bassensis* (Parr). The writer is indebted to Mr K. N. Bell for drawing his attention to a paper by Adegoke, Dessauvagie and Yoloye (1969) in which a similar form from brackish-water lagoons in Nigeria, first thought to be a species of *Hemisphaerammina*, was found to be the egg-capsule of a gasteropod, *Neritina* sp. Following this hint, specimens were broken open or detached, and in some cases were found to contain a chitinous molluscan protoconch (fig. 49), a parallel situation to that in the above reference. Accordingly, Parr's species is not a foraminiferid, and the name must be allowed to lapse.

As might be expected, these capsules differ in some respects from the Nigerian form. They are usually more than half an oblate spheroid in shape, contracting in diameter toward the base. The wall is comparatively thick, consisting of fine sand grains weakly cemented, with scattered larger grains built in and appearing on the surface. Another difference is that each capsule contains one embryo only which nearly fills the cavity, rather than several as in the Nigerian example.

The relationship of these egg-capsules is yet to be established. *Neritina* spp. are found in estuarine conditions in N.S.W. and Qld., but the genus does not appear to have been recorded locally. As it no longer concerns the foraminiferid fauna of the Survey, the question is left for future investigation.

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Explanation of Plates 1-4

PLATE 1

1. *Reophax barwonensis* sp. nov. Holotype, x88.
2. *Haplophragmoides pusillus* sp. nov. Holotype, 'a' side view, 'b' apertural view, x88.
3. *Ammobaculites? barwonensis* sp. nov. Holotype, 'a' side view, 'b' end view, x88.
4. *Ammotium australiensis* (Collins). 'a' side view, 'b' apertural view, x44.
5. *Trochammina* sp. A. 'a' umbilical side view, 'b' spiral side view, 'c' apertural view, x82.
6. *Quinqueloculina poeyana victoriensis* subsp. nov. Holotype, 'a' side view, 'b' apertural view, x66.
7. *Triloculina sabulosa* sp. nov. Holotype, 'a' side view, 'b' apertural view, x82.
8. *Scutuloris parri* sp. nov. Holotype, 'a' and 'b' side views, 'c' apertural view, x82.
9. *Dimorphina* sp. A. x44.
10. *Lagena bassensis* sp. nov. Holotype, x88.
11. *Lagena lonsdalensis* sp. nov. Holotype, x66.
12. *Lagena nepeanensis* sp. nov. Holotype, x88.
13. *Lagena portseaensis* sp. nov. Holotype, x88.
14. *Bolivinella pendens* sp. nov. Holotype, 'a' side view, 'b' apertural view, x88.
15. *Laryngosigma australiensis* sp. nov. Holotype, 'a' side view, 'b' apertural view, x88.
16. *Oolina guttaformis* sp. nov. Holotype, 'a' side view, 'b' apertural view.

PLATE 2

17. *Fissurina crassiannulata* sp. nov. Holotype, 'a' side view, 'b' edge view, x88.
18. *Fissurina furcata* sp. nov. Holotype, 'a' side view, 'b' edge view, x110.
19. *Fissurina multipunctata* sp. nov. Holotype, 'a' side view, 'b' apertural view, x110.
20. *Fissurina pseudoformosa* sp. nov. Holotype, 'a' side view, 'b' edge view, x88.
21. *Pavonina triformis* Parr. Figured specimen, x88.
22. *Euuvigerina compacta* sp. nov. Holotype, 'a' side view, 'b' apertural view, x88.
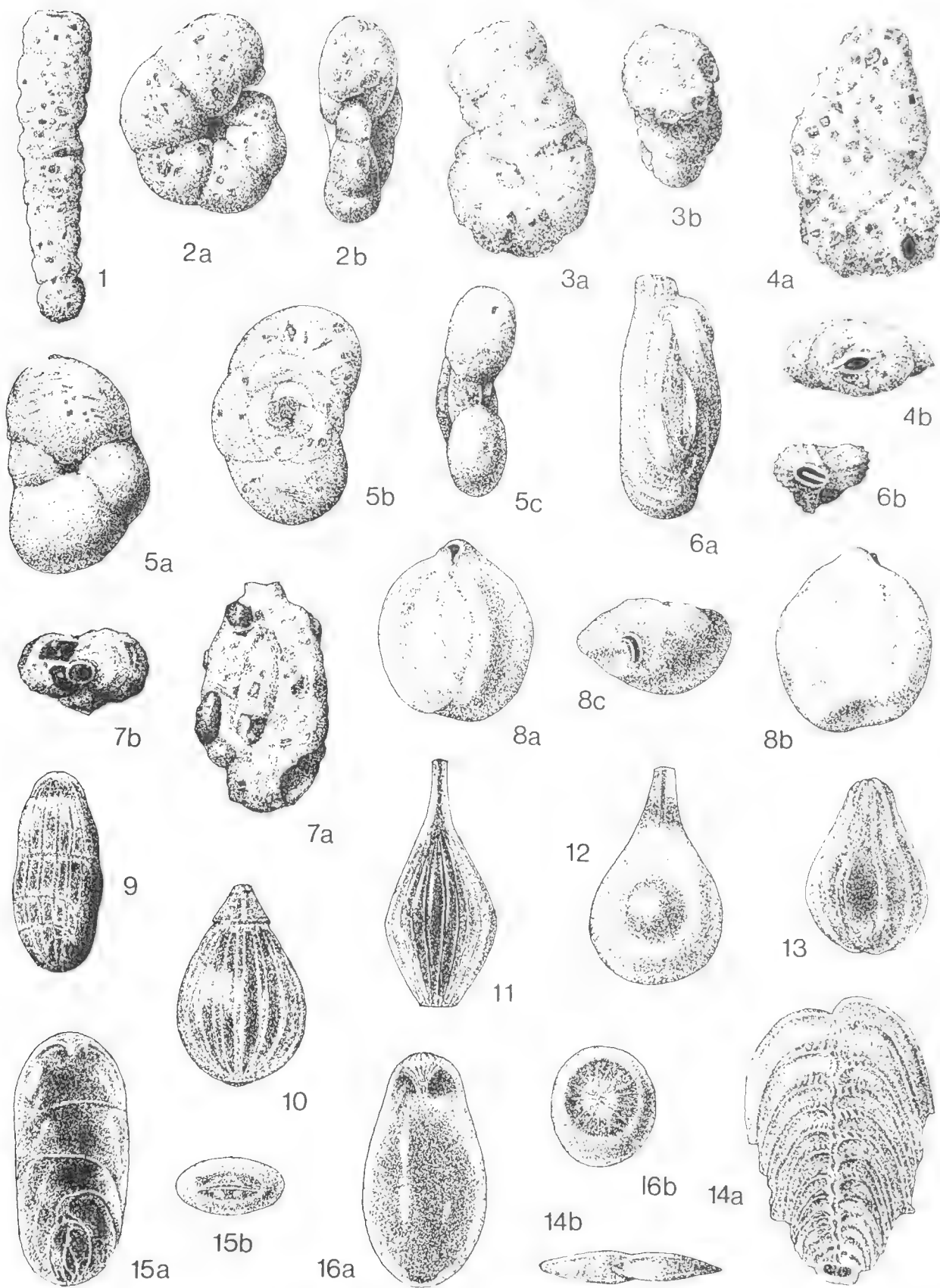23. *Hopkinsina victoriensis* sp. nov. Holotype, 'a' side view, 'b' apertural view, x88.

24. *Discorbinella infrapapillata* sp. nov. Holotype, 'a' spiral side, 'b' umbilical side, 'c' edge view, x88.
25. *Neoconorbina terquemi* (Rzehak). Figured specimen, 'a' spiral side, 'b' umbilical side, 'c' edge view, x88.
26. *Pseudohelenina collinsi* (Parr) gen. nov. Plesiotype, 'a' spiral side, 'b' umbilical side, 'c' edge view, x50.
27. *Rugidia simplex* sp. nov. Holotype, 'a' spiral side, 'b' umbilical side, 'c' edge view, x88.
28. *Valvulineria minutissima* sp. nov. Holotype, 'a' spiral side, 'b' umbilical side, 'c' edge view, x88.

PLATE 3

29. *Valvulineria victoriensis* sp. nov. Holotype, 'a' umbilical side, 'b' spiral side, 'c' edge view, x70.
30. *Ammonia aoteanus* (Finlay). 'a' umbilical side, 'b' spiral side, 'c' edge view, x44.
31. *Elphidium articulatum multicameratum* subsp. nov. Holotype, 'a' side view, 'b' edge view, x44.
32. *Elphidium earlandi avalonense* subsp. nov. Holotype, 'a' side view, 'b' edge view, x88.
33. *Elphidium granulosum* sp. nov. Holotype, 'a' side view, 'b' edge view, x88.
34. *Elphidium gunteri corioense* subsp. nov. Holotype, 'a' side view, 'b' edge view, x88.
35. *Elphidium vitreum* sp. nov. Holotype, 'a' side view, 'b' edge view, x 88.
36. *Rosalina parri* sp. nov. Plesiotype, 'a' umbilical side, 'b' spiral side, 'c' edge view, x44.
37. *Planulina bassensis* sp. nov. Holotype, 'a' umbilical side, 'b' spiral side, 'c' edge view, x84.
38. *Cibicides* sp. A. 'a' umbilical side, 'b' spiral side, 'c' edge view, x 44.
39. *Cibicides* sp. A. *Dyocibicides*-form, spiral side, x44.
40. *Cibicides* sp. A. *Rectocibicides*-form, umbilical side, x55.

PLATE 4

41. *Cibicides phillipensis* sp. nov. Holotype, 'a' umbilical side, 'b' spiral side, 'c' edge view, x44.
42. *Cibicides wattsi* sp. nov. Holotype, 'a' umbilical side, 'b' spiral side, 'c' edge view, x88.
43. *Planorbulina* sp. A. 'a' general view, 'b' part edge view showing multiple apertures, x44.
44. *Cassidulina* sp. A. 'a' side view, 'b' edge view, x88.
45. *Cassidulina victoriensis* sp. nov. Holotype, 'a' apertural side, 'b' other side, 'c' edge view, x88.
46. *Nonionella pulchella* Hada. x110.
47. *Nonionella vortex* sp. nov. Holotype, 'a' and 'b' side views, 'c' edge view, x110.
48. *Trichohyalus australis* sp. nov. 'a' umbilical side, 'b' spiral side, 'c' edge view, x88.
49. "*Webbinella bassensis* Parr". Two egg-capsules deposited one over another on a molluscan shell, x36.
50. "*Webbinella bassensis* Parr". Basal view of capsule detached from substrate, showing contained molluscan embryo, x44.
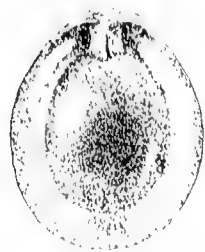
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31a

31b

32a

32b

30b

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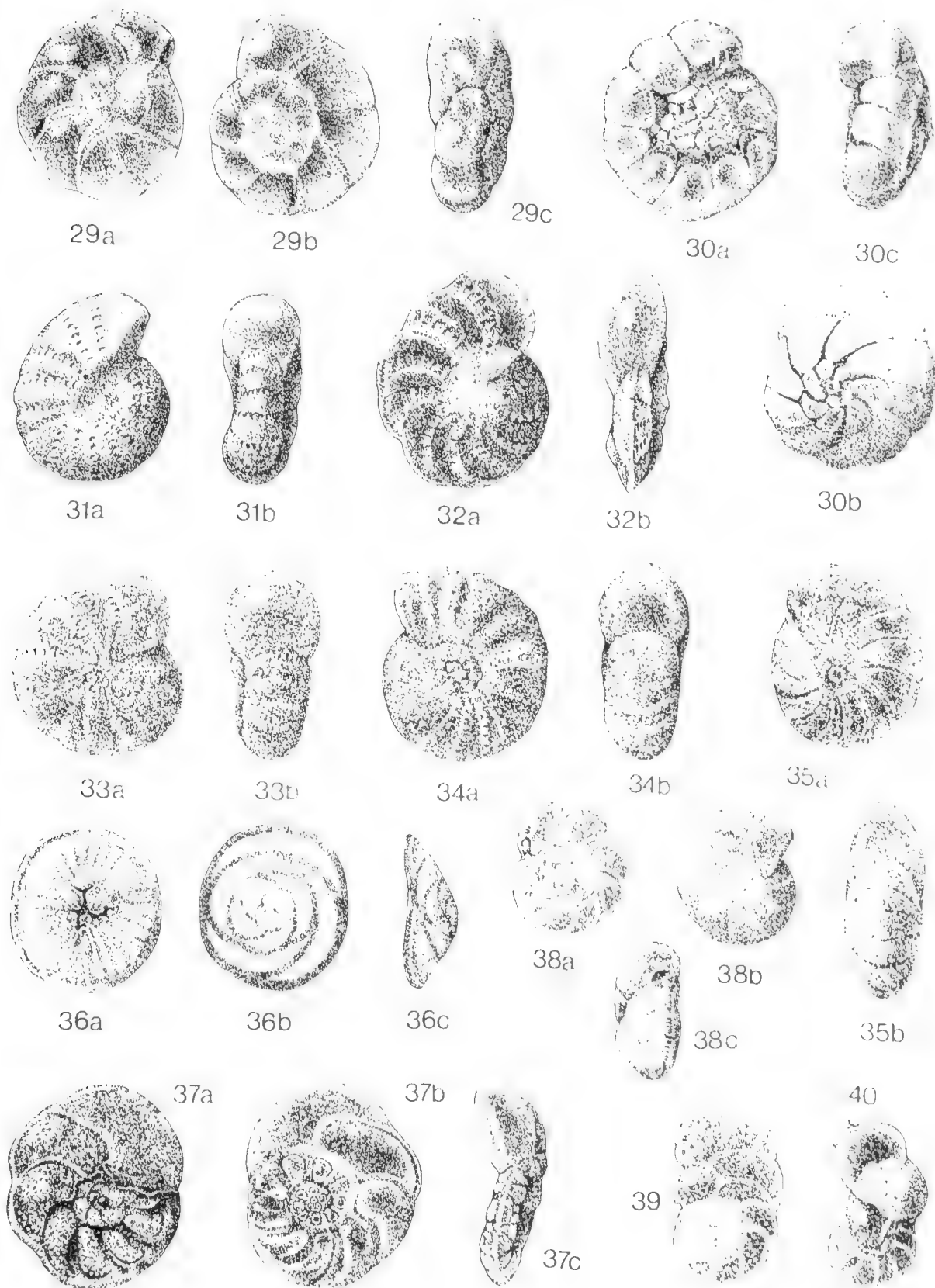
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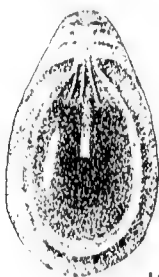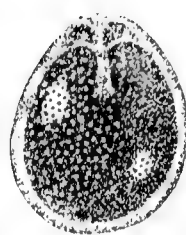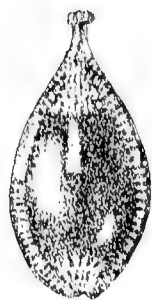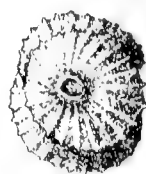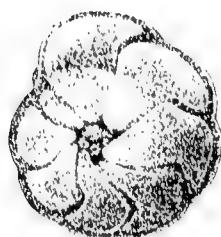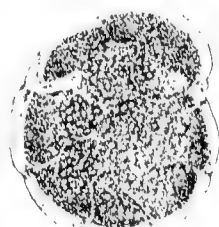
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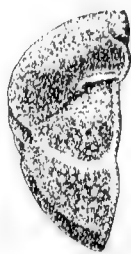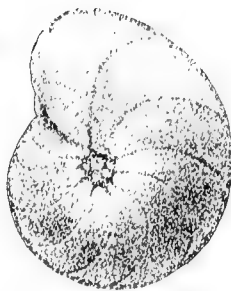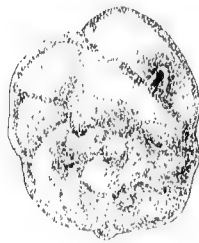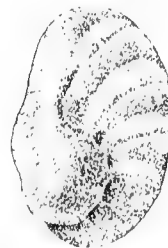
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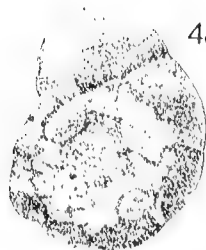
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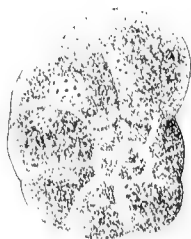
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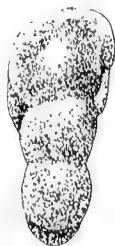
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LATE PLEISTOCENE MAMMALS FROM THE "KEILOR CRANIUM SITE", SOUTHERN VICTORIA, AUSTRALIA

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Abstract

Two late Pleistocene mammal faunas have been recorded from the "Keilor Cranium Site", southern Victoria, Australia. The older late Pleistocene Dry Creek Local Fauna from the "D Clay" includes *Sarcophilus laniarius*, *Thylacinus cynocephalus*, *Perameles nasuta*, *Vombatus ursinus*, *Thylacoleo carnifex*, *Protemnodon anak*, *P. brehus*, *Macropus rufogriseus*, *M. agilis*, *M. titan*, *M.* cf. *ferragus*, and *Zygomaturus trilobus*. Disconformably overlying the "D Clay" is the slightly younger Doutta Galla Silt with a basal age of 18,000 yr B.P. The Maribyrnong Local Fauna of the Doutta Galla Silt is represented by *Vombatus ursinus*, *Megaleia rufa*, *Macropus giganteus*, *Mastacomys fuscus*, *Pseudomys* cf. *australis* and *Pseudomys* cf. *gracilicaudatus*. Late-Pleistocene dwarfing is demonstrated in four species in the Dry Creek Local Fauna and two species in the Maribyrnong Local Fauna, with one species common to both. Late Pleistocene extinctions and late-Pleistocene dwarfing were probably caused by a common factor. The term megafauna is defined to include (1) species now extinct, and (2) species which have undergone late-Pleistocene dwarfing.

Introduction

For nearly two decades fossil mammals have been known from the Doutta Galla Silt in southern Victoria, Australia; these include *Rattus* cf. *assimilis*, and species of kangaroos, wallabies, wombats and native cats similar to those living today (Gill 1955a,b). A C_{14} date of $18,000 \pm 500$ yr B.P. (NZ-207), obtained on a charcoal sample from the base of the Doutta Galla Silt, indicates that the fauna is of latest Pleistocene age (10,000 yr B.P. is accepted here as the Pleistocene-Holocene boundary).

Disconformably underlying the Doutta Galla Silt at the Keilor Cranium Site is an unnamed dark unit referred to by Gallus (1971) as the "D Clay", from which are recorded species of *Diprotodon* and *Thylacoleo* (Gill 1967).

Over the past eight years Dr. A. Gallus and a team of workers from the Archaeological Society of Victoria have made a large collection of fossil mammals from the Keilor Cranium Site, both from the Doutta Galla Silt and "D Clay". These faunas are described here as the Maribyrnong Local Fauna and Dry Creek Local Fauna respectively.

Locality

"1940 Cranium Site" of Bowler (1970, p. 17, fig. 1). One mile N. of Keilor at confluence of Dry Creek and Maribyrnong River, S. Vict., Australia. Grid ref. 881495 on Sunbury Military Map.

Methodology

Linear tooth dimensions were measured with a pair of vernier calipers to the nearest 0·1 mm when possible. All measurements are in millimetres unless indicated otherwise.

The following abbreviations are used:

a—approximate measurement
AW—anterior width (protoloph and protolophid width)
DB—distal breadth
DD—distal depth
DP—deciduous premolar
L—length
M—molar
MW—maximum width
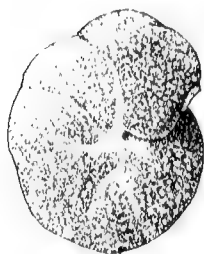P—premolar
PB—proximal breadth
PD—proximal depth
PW—posterior width (metaloph and hypolophid width)

The specimens described here were deposited in the fossil collections of the National Museum of Victoria (NMV), Melbourne, Australia. The roman numerals following the

specimen numbers in the tables refer to the level from where that specimen was collected. A complete list of the identifiable specimens from each level of the "D Clay" is given in Appendix 1. The specimens from the Doutta Galla Silt are listed in Appendix 2. The higher taxonomic categories are of Ride (1964).

1. "D Clay" (Dry Creek Local Fauna)

Because there are no detailed studies of the complex stratigraphy at the Keilor Cranium Site, I will restrict my comments to the general relationships between the fossil bearing units.

Three basic mapable units are recognizable at the Keilor Cranium Site: (1) the Arundel Formation, (2) an unnamed intermediate unit, and (3) the Doutta Galla Silt, from oldest to youngest (formational names follow Gill 1962). All three of these units are separated by disconformities. The relationship of the Arundel Formation and Doutta Galla Silt are discussed by Bowler (1970). The intermediate unnamed unit has been referred to as the "D Clay" by Gallus (1971), although it has not been formally named. The age of the "D Clay" has yet to be established, although it is certainly late Pleistocene in age and probably in the order of 25,000-40,000 yr B.P. (J. M. Bowler, pers. comm.). The material described here as the Dry Creek Local Fauna was collected from the "D Clay".

During initial excavation of the fossil materials from the Doutta Galla Silt, Gallus organized his collections on the basis of their relationship of one to the other (local concentrations) and on superpositional relationships where this was clearly defined. Differences in the lithology of the sediment were also taken into account. For the most part the collection is organized into specific collection sites (layers or levels as sometimes used by Gallus) and the relationships of these sites to each other have not been firmly established. In the interest of convenience and clarity I have given "level" numbers to each of Gallus's collection sites (Appendix 1). These levels (I-XI) are roughly organized such that level I probably represents the oldest and level XI probably represents the youngest, although this is only an approximation and needs further clarification. Until the stratigraphic and time relationships of these levels are worked out in detail it is not possible to discuss differences in faunal composition within the different levels in any meaningful context.

The Fauna

The Dry Creek Local Fauna consists of 12 species of marsupials representing three orders and seven families. Two of these families, Diprotodontidae and Thylacoleonidae, are now extinct; the other five families, Thylacinidae, Dasyuridae, Peramelidae, Vombatidae, and Macropodidae, are represented by extant species. Table 1 lists the minimum number of individuals of each species necessary to account for all of the specimens recovered from each level (based on both dental and postcranial remains).

Macropods are the dominant group, comprising 76% of the total minimum number of individuals and are represented by at least five, and possibly as many as six, species (*Protemnodon anak*, *P. brehus*, *Marcopus rufogriseus*, *M. agilis*, *M. titan*, *M.* cf. *ferragus*). *Macropus titan* is the most abundant species in most of the levels, followed by *M. rufogriseus* and *M. agilis* which appear in about equal numbers. The other species appear rather sporadically throughout and are not abundant in any particular level. The ratio of carnivores (*Sarcophilus laniarius*, *Thylacinus cynocephalus*, *Thylacoleo carnifex*) to herbivores (all other species) is approximately 1 : 10.

The species in the fauna can be placed into three basic groups: (1) species represented by living forms indistinguishable from specimens in the fauna (*Perameles nasuta*, *Vombatus ursinus*, *Macropus rufogriseus*); (2) the larger Pleistocene forms of living species (*Sarcophilus laniarius*, *Thylacinus cynocephalus*, *Macropus agilis*, *M. titan*), and (3) species now extinct (*Thylacoleo carnifex*, *Protemnodon anak*, *P. brehus*, *Macropus* cf. *ferragus*, and *Zygomaturus trilobus*).

TABLE 1

Under "levels" I-XI from the "D Clay" are listed the minimum number of individuals necessary to account for the specimens recovered from each "level" based on both dentitions and postcranial remains. The minimum number of individuals of each species in the total fauna based solely on dentitions is given in the right-hand column.

Species	Level I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Total
Sarcophilus laniarius	-	-	-	1	1	1	-	-	-	-	-	1
Thylacinus cynocephalus	-	-	-	-	-	1	-	-	-	-	-	1
Perameles nasuta	-	-	1	-	-	-	-	-	-	-	-	1
Vombatus ursinus	-	-	2	1	-	-	-	-	-	-	-	2
Thylacoleo carnifex	-	-	-	-	-	-	-	-	-	-	1	1
Protemnodon anak	-	-	-	-	1	-	-	-	-	-	1	2
Protemnodon brehus	-	-	1	-	-	-	-	-	1	-	-	1
Protemnodon sp.	-	-	1	-	-	1	-	-	1	1	-	-
Macropus rufogriseus	-	-	-	1	1	1	1	-	-	-	1	3
Macropus agilis	-	-	-	3	1	1	1	-	-	-	-	5
Macropus titan	-	1	3	2	2	3	3	2	1	1	3	13
Macropus cf. ferragus	-	-	1	-	-	-	-	-	-	-	-	1
macropodid	-	2	1	2	2	1	-	1	1	1	1	-
Zygomaturus trilobus	1	1	-	-	-	-	-	-	-	-	-	2
diprotodontid	-	-	-	-	-	-	-	1	-	-	1	-
Total	1	4	10	10	8	9	5	4	4	3	8	33

Dry Creek Local Fauna

Class Mammalia
  Infraclass Metatheria
    Superorder Marsupialia
      Order Marsupicarnivora
        Family Dasyuridae
          Sarcophilus laniarius
        Family Thylacinidae
          Thylacinus cynocephalus
      Order Peramelina
        Family Peramelidae
          Perameles nasuta
      Order Diprotodonta
        Family Vombatidae
          Vombatus ursinus
        Family Thylacoleonidae
          Thylacoleo carnifex
        Family Macropodidae
          Protemnodon anak
          Protemnodon brehus
          Macropus rufogriseus
          Macropus agilis
          Macropus titan
          Macropus cf. *ferragus*
        Family Diprotodontidae
          Zygomaturus trilobus

Palaeoecology

The probable habitat preferences of the species in the Dry Creek Local Fauna (Table 2) are based on those of extant populations. It is assumed that the larger late Pleistocene forms (*Sarcophilus laniarius, Macropus titan*) had habitat requirements similar to their living descendants (*S. harrisii* and *M. giganteus* respectively). These data show that the region in the Dry Creek area in late Pleistocene time was most probably covered by sclerophyll forest. It is possible that mesophytes lined the river valleys which dissected the open rolling bushlands and grasslands much as occurs in the area today.

Faunal Correlation

Lake Colongulac (= Lake Timboon)
The Dry Creek Local Fauna compares well with the late Pleistocene fauna from Lake Colongulac, N. of Camperdown, S. Victoria. The following species are represented in the Lake Colongulac Local Fauna:
Class Mammalia
    Superorder Marsupialia
      Order Marsupicarnivora

TABLE 2

Basic habitat preferences of species in the Dry Creek Local Fauna based on living populations of these species (x indicates preferred habitat).

Species	Rain-forest	Sclerophyll forest	Woodland	Plains
Sarcophilus laniarius[*] (as S. harrisii)		x		
Thylacinus cynocephalus[*]		x	x	
Perameles nasuta[+]	x	x	x	
Vombatus ursinus[+]		x		
Macropus titan[+] (as M. giganteus)		x	x	x
Macropus agilis[*]		x	x	x
Macropus rufogriseus[+]		x	x	

+ from Marlow (1958)   * from Ride (1970)

Family Dasyuridae
    Sarcophilus laniarius (P30218)
Family Thylacinidae
    Thylacinus rostralis (see DeVis 1899)
Order Diprotodonta
  Family Vombatidae
    Lasiorhinus sp.?
    Vombatus ursinus (P30785)
  Family Thylacoleonidae
    Thylacoleo carnifex (P24000) (Type locality)
  Family Macropodidae
    Sthenurus sp. (P29488)
    Procoptodon rapha (P26901)
    Thylogale billardierii (P23996)
    Protemnodon anak (P30207)
    Protemnodon brehus (P30214)
    Macropus rufogriseus (P30217)
    Macropus agilis (*M. siva*?) (P30215)
    Macropus titan (P28549)
  Family Diprotodontidae
    Diprotodon optatum (P15902)

A large collection of fossil mammals from Lake Colongulac and the surrounding lake region (generally referred to as the Camperdown District) is in the National Museum of Victoria; but unfortunately this important fauna has not been adequately described. The diversity of this fauna is considerably greater than previously recognized as is seen in comparing the faunal list given by Gill (1953b, p. 35) with the revised and expanded list given above. The fauna from Lake Colongulac and that from Dry Creek are similar in age and share a close geographical proximity; differences between these faunas are probably due to sampling.

Murray River Basin

Late Pleistocene local faunas from the Lower Murray River Basin have been recovered from Lake Menindee (Tedford 1967), Lake Tandou (Merrilees 1973), and Lake Victoria (Marshall 1973). These faunas are typified by an abundance of grazers (*Macropus ferragus*, *M. titan*) and browser-grazers (*Sthenurus tindalei*, *S. andersoni*, *S. atlas*, *Protemnodon brehus*, *P. anak*, *Osphranter*

cooperi) and dominated by the large browsing macropod *Procoptodon goliah*.

The Lake Victoria Local Fauna (which is typical of the Murray River Basin faunas) is considerably different from that of the Dry Creek Local Fauna. Five of the twelve species in the Dry Creek Local Fauna (*Perameles nasuta*, *Vombatus ursinus*, *Macropus agilis*, *M. rufogriseus*, and *Zygomaturus trilobus*) are absent from the Lake Victoria Local Fauna whereas *Perameles gunnii*, *Lasiorhinus Krefftii*, *Lagorchestes leporides*, *Onychogalea fraenata* and *Diprotodon optatum* occur in the Lake Victoria Local Fauna and not in the Dry Creek Local Fauna. These faunal differences are probably the result of the presence of an open woodland-savannah-grassland in the Murray River Basin during late Pleistocene time.

The Collection

The major part of the fossil materials were collected *in situ* as isolated specimens. A few associated left and right rami were obtained, although these finds are certainly exceptions. Most of the postcranial material was broken except for podial and metapodial bones. Because of the dearth of associations it is difficult to assign postcranial elements to respective dentitions with complete certainty. In the case of *Protemnodon*, all podial elements are referred to *Protomnodon* sp. as there were no feet of *P. anak* or *P. brehus* available for comparison. All of the postcranial elements of a large species of *Macropus* are referred to *M. titan*. Although associated rami (P30716) are referred to *M.* cf. *ferragus*, the presence of this species in the fauna cannot be established with complete certainty (see below). The postcranial remains of smaller species of *Macropus* are potentially referable to *M. agilis* or *M. rufogriseus* and some may even be referable to females? of *M. titan*; these are all listed collectively under the heading macropodid. The postcranial remains of a diprotodontid are probably referable to *Zygomaturus trilobus*. Except for basing the identification of *Thylacinus cynocephalus* on a humerus, the identifications of all other species in the fauna are based on teeth. Nearly one third of the total bone sample consists of postcranials which are

too fragmented to permit reasonably accurate identification. These specimens are not discussed in this study although their presence is recorded for completion.

Systematics Review

Class Mammalia
Infraclass Metatheria
Superorder Marsupialia
Order Marsupicarnivora
Family Dasyuridae
Sarcophilus laniarius (Owen, 1838)

Specimens of *Sarcophilus laniarius* were collected from levels IV, V, and VI. As there is no duplication in the elements represented they may in theory be attributed to a single individual (Table 3).

The relationship of L M^2 and MW M^2 of P29587 from Dry Creek is compared in Fig. 1 with an extant sample of *Sarcophilus harrisii* from Tasmania and a sample of *S. laniarius* from late Pleistocene deposits in Strathdownie Cave, Victoria (Merrilees 1965). The Dry Creek specimen falls well within the range of the *S. laniarius* sample.

No morphological differences were observed in the dentitions of the *S. laniarius* or *S. harrisii* samples studied, and except for the superior size of the former (approximately 15% based on tooth measurements) separation of the dentitions of these species was difficult. *S. laniarius* is typically found in deposits of late Pleistocene age in direct association with extinct megafaunal species of *Procoptodon*, *Protemnodon*, *Sthenurus*, and *Zygomaturus*, to name just a few. *S. harrisii*, on the other hand, occurs in slightly younger deposits always in association with a typically modern fauna (for example see Thorne 1972). Although the association of specimens of *S. harrisii* with extinct megafaunal species are reported (Owen 1877) the contemporaneity of these species is highly questionable (Frank 1971). The direct association and temporal overlap of these species have not been substantiated. This evidence suggests that *S. laniarius* represents a larger, ancestral, late Pleistocene form of *S. harrisii*; a relationship first recognized by Lydekker (1887).

Fig. 1—Scatter diagram showing relationship of L M^2 and MW M^2 of a living sample of *Sarcophilus harrisii* from Tasmania, a fossil sample of *S. laniarius* from late Pleistocene deposits in Victoria, and a specimen (P29587) referable to *S. laniarius* from the Dry Creek Local Fauna.

TABLE 3

Dimensions of the cheek teeth of *Sarcophilus laniarius*

Specimen	P^2		M^1		M^2		M^3	M^4	
	L	MW	L	MW	L	MW	L	L	MW
P29587 (VI)	–	–	12.2	9.7	14.6	11.3	13.7	9.2	4.7
P29631 (V)	6.8	6.0	–	10.0	–	–	–	–	–

Family Thylacinidae

Thylacinus cynocephalus (Harris, 1808)

A single left humerus (P29588) collected from level VI is the only element referable to this species.

Ride (1964) reviewed the status of the five proposed species of *Thylacinus* (*T. major* Owen 1877, *T. breviceps* Krefft 1871, *T. spelaeus* Owen 1845, *T. cynocephalus* Harris 1808, and *T. rostralis* DeVis 1894). Ride's study of dental and cranial characters of a living sample of *Thylacinus* from Tasmania, and fossil samples from cave deposits in W. and E. Australia "do not support separation [of these samples] even at a subspecific level at the present time". Ride recognized that these

samples represent a single variable species, *T. cynocephalus*, which includes *T. breviceps* and *T. spelaeus* as junior synonyms (see footnote of Ride 1964, p. 105 concerning the identity of *T. major*). Ride further noted, "although recognition by name is not justified there is no doubt that in the Pleistocene of W. Australia there existed a population of *Thylacinus cynocephalus* which on an average contained smaller individuals than the modern form (and by inference its eastern Pleistocene representative)". *T. rostralis* from the late Pleistocene fluviatile deposits of the E. Darling Downs, SE. Queensland was shown to be larger than the specimens referred to *T. cynocephalus* by Ride. Ride recommended that *T. rostralis* retain its specific identity, at least for the time being.

The Dry Creek specimen agrees well in morphology with the living specimens of *T. cynocephalus* from Tasmania (NMV C5742, C5746, C5753) with which it was compared, although the Tasmanian specimens are slightly smaller. No specimens of postcranial material referable to *T. rostralis* were available for study and it may be that the Dry Creek specimen is referable to this species. DeVis (1899) reported *T. rostralis* from Lake Colongulac in S. Victoria. I was unable to relocate the specimen(s) upon which this identification was based.

The Dry Creek specimen agrees well in size and morphology with a nearly complete skeleton of *T. cynocephalus* (P26573) from late Pleistocene deposits at Lake Victoria, N.S.W. The cranial dimensions of P26573 fall well within the range of males of *T. cynocephalus* studied by Ride (1964).

Order Peramelina
Family Peramelidae

Perameles nasuta Geoffroy, 1804

A right ramus fragment with P_1-M_3 and an associated fragment of a left maxillary with M^{2-3} (P29634) of this species were found in level III (Table 4).

The upper molars of species of *Isoodon* possess a well developed hypocone which is subequal in size to the protocone. In species of *Perameles* a hypocone is absent or only incipiently developed. The Dry Creek specimen has only an incipiently developed hypocone and is readily referred to a species of *Perameles*. The dentitions of *Macrotis*, *Chaeropus* and *Echimiptera* are sufficiently distinct from *Perameles* and *Isoodon* to dispense with a detailed comparison with the Dry Creek specimen.

The L M_3 and AW M_3 of living samples of *Perameles bougainville* (including *P. fasciata*, *P. myosura*, *P. arenaria*; see Tate 1948, pp. 324-325), *P. gunnii*, and *P. nasuta* are compared with the Dry Creek specimen in Fig. 2. Values of the dental parameters of *P. bougainville* are significantly smaller than those of the other two species. Freedman (1967) reported that the teeth of *P. gunnii* and *P. nasuta* "are of approximately similar size" although those of *P. gunnii* were shown to be slightly smaller. He noted that the dentitions of these species could be separated by differences in the morphology of the upper incisors and canine. Unfortunately, these teeth are not represented in the collection from Dry Creek. I was unable to find morphological differences in the molar teeth of these species which would allow them

TABLE 4

Dimensions of the cheek teeth of Perameles nasuta

Specimen	P1		P2		M1			M2			M3		
	L	MW	L	MW	L	AW/MW	PW	L	AW/MW	PW	L	AW/MW	PW
Upper P29634 (III)	-	-	-	-	-	-	-	4.0	4.0	-	3.8	3.9	-
Lower P29634 (III)	2.9	0.9	3.3	1.3	3.9	2.2	2.6	4.1	2.6	3.0	4.2	2.5	2.7

to be distinguished. As seen in Fig. 2, *P. gunnii* is slightly smaller than *P. nasuta*. The Dry Creek specimen falls within the range of the *P. nasuta* sample and outside of the *P. gunnii* sample. The Dry Creek specimen is tentatively referred to *P. nasuta* based on this (admittedly minor) size difference.
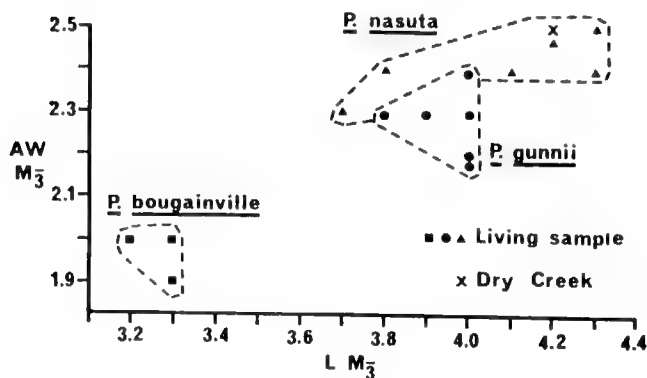
Fig. 2—Scatter diagram showing relationship of L M₃ and AW M₃ for living samples of *Perameles bougainville*, *P. gunnii*, and *P. nasuta*, and a fossil specimen of *Perameles* from the Dry Creek Local Fauna.

Order Diprotodonta

Family Vombatidae

Vombatus ursinus (Shaw, 1800)

A minimum of two individuals of *Vombatus ursinus* are represented by two rami (P23026, P29519) and a fragment of a left ilium (P29548), collected from levels III and IV respectively. Remains of this species are commonly found in late Pleistocene deposits throughout Victoria, E. New South Wales and S. Queensland.

The molars of *V. ursinus* typically have W-shaped lobes and sharp interlobe valleys as opposed to the more U-shaped or rounded lobes and more open interlobe valleys of *Lasiorhinus* (Merrilees 1967, p. 407).

Family Thylacoleonidae

Thylacoleo carnifex Owen, 1858

A single fragment from level XI of a right maxillary (P29545) with the lower edge of the orbit and the anterior root of P³ is all that is known of this species.

At the present time one late Pleistocene species, *T. carnifex*, is recognized and is virtually pan-Australian in distribution. Merrilees (1968) reports *Thylacoleo* sp. not *T. carnifex* from Mammoth Cave in SW. W. Aust. This specimen(s) has not been described and I do not know how it differs from *T. carnifex*.

Mylodon australis Krefft 1870, *Thylacoleo oweni* McCoy 1876, and *Thylacopardus australis* Owen 1888 are presently recognized as junior synonyms of *T. carnifex* (Anderson 1929). A concise description of the cranium and dentition of this species is given by Woods (1956) and the species distribution is outlined by Gill (1954).
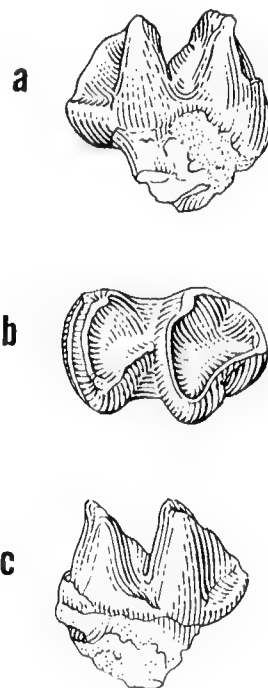
Fig. 3—*Protemnodon anak*, right M₃, NMV P29555, level V; a, lingual; b, occlusal; and c, labial views; all x 1½.

Family Macropodidae

Protemnodon anak Owen, 1873

Dentitions of *Protemnodon anak* were found in levels V (P29554, P29555) and XI (P29604), representing a minimum of two individuals (Table 5). Postcranial remains from levels III, VI, IX and X may be referable to this species (Table 9). These specimens

agree in all respects with the holotype (BMNH M1895) figured by Stirton (1963, p. 136, fig. 13a,b) (Fig. 3).

TABLE 5

Dimensions of the cheek teeth of
Protemnodon anak and *P. brehus*

Specimen	P3		M3				M4		
	L	PW	L	AW	PW	L		AW	PW
P. brehus									
Upper									
P29522 (III)	–	–	–	–	13.1	19.2a		–	12.8
Lower									
P29628 (IX)	–	–	16.5	11.5	11.5	17.7		–	
P. anak									
Lower									
P29604 (XI) (left)	–	–	13.7	–	–	15.6		–	9.8
P29604 (XI) (right)	15.0	5.5	13.5a	–	–	15.7		–	10.0

Protemnodon brehus (Owen, 1874)

Dentitions of this species were found in levels III (P29522) and IX (P29628). An isolated right lower incisor (P29586) from level VI is probably referable to this species. These specimens represent the first record of *P. brehus* in Victoria.

P29522 agrees in all respects with the holotype (BMNH 43303a) figured by Stirton (1963, p. 140, fig. 15b). The lower molars of *P. brehus*, as represented by P29628, differ from those of *P. anak* (P29601) in being larger and relatively broader (Table 5). Both species have weakly developed cingula on the lower molars.

Macripus rufogriseus (Desmarest, 1817)

Dentitions of this species were found in levels IV-VII and XI, and represent a mini-

mum of three individuals (Table 6). Some of the postcranials from levels II-VI, VIII-XI listed under macropodid may be referable to this species.

In Fig. 4 the Dry Creek specimens are compared with specimens of *M. rufogriseus* from an extant population. There is complete overlap in the range of the two samples. *M. rufogriseus* is found as a living species in the Dry Creek area; the living firms are indistinguishable in size and tooth morphology from the specimens in the Dry Creek Local Fauna.
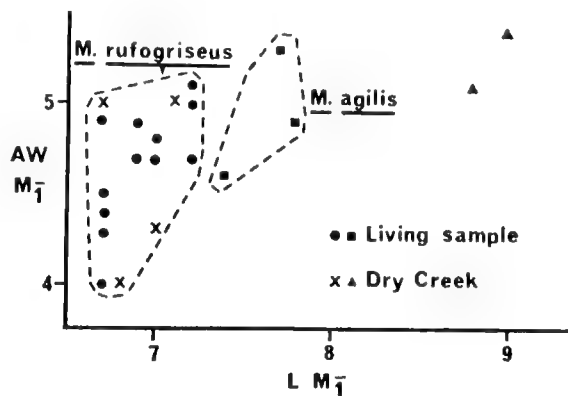

Fig. 4—Scatter diagram showing relationship of L M_1 and AW M_1 of a living sample of *Macropus agilis* (squares) and *M. rufogriseus* (circle) and specimens referable to *M. agilis* (triangles) and *M. rufogriseus* (x) from the Dry Creek Local Fauna.

Macropus agilis (Gould, 1842)

Macropus agilis is the second most abundant species in the fauna and is represented by a minimum of five individuals (Table 7, Figs. 5, 6). *M. agilis*, like *M. rufogriseus*, is repre-

TABLE 6

Dimensions of the cheek teeth of *Macropus rufogriseus*

Specimen	DP3	P3			M1			M2			M3		M4	
	PW	L	AW	PW	L	AW	PW	L	AW	PW	L	PW	L	AW
Upper														
P29578 (V)	–	–	–	–	–	–	–	–	6.9	6.9	8.3	–	9.0	7.0a
Lower														
P29577 (IV)	–	4.3	–	–	7.1	5.0	–	7.9	–	–	–	–	–	–
P29574 (XI)	–	4.1	1.6	1.8	6.7	5.0	5.4	7.6	5.4	5.4	8.6	5.5	–	–
P30905 (VII)	4.2	–	–	–	7.0	4.3	4.7	7.6	5.3	5.3	–	–	–	–
P30725 (IV)	–	–	–	–	6.8	4.0	–	–	–	–	–	–	–	–

sented by dental remains in levels IV-VII, although is not present in level XI. Some of the postcranials from levels II-VI, VIII-XI may well prove to be referable to this species.

DeVis (1895) erected *M. siva* on the basis of a partial ramus collected from the late Pleistocene fluviatile deposits of the E. Darling Downs in SE. Queensland (see Bartholomai 1966, pp. 118-119). Specimens referable to *M. siva* have subsequently been recorded from late Pleistocene deposits in Mount Hamilton Cave, Victoria (Wakefield 1963, p. 326; as *M. cf. M. siva*), the Frenchman's Creek Local Fauna in SW. New South Wales, and Wellington Caves, N.S.W. (Marshall 1973).

Specimens recognized as *M. siva* are typically larger than *M. agilis*, but except for this small size difference the dentitions of these species are indistinguishable. *M. siva* is reported only from deposits of late Pleistocene age. The most logical explanation regarding the relationship of these two species is that *M. siva* probably represents a slightly larger late Pleistocene form of *M. agilis*. No large samples of *M. siva* have been described and what materials have been referred to this species consist either of isolated specimens or small samples. Thus the precise size difference between populations of *M. siva* and *M. agilis* has yet to be established; I would estimate it to be in the order of 10-15%. A detailed study may show these species to be conspecific.

In Fig. 4 the dimensions of the Dry Creek specimens are compared with three specimens of *M. agilis* from a living population and show
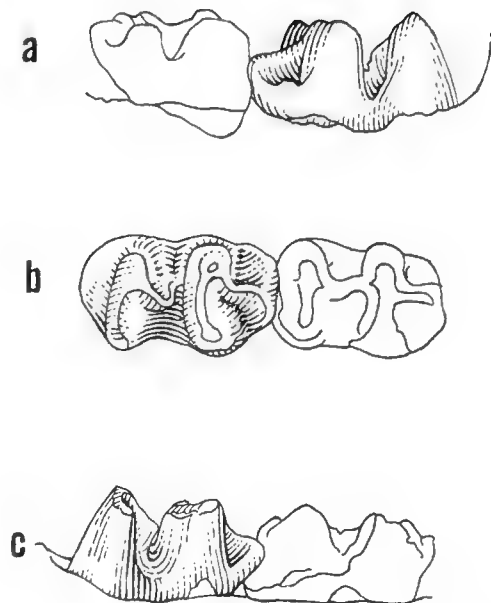
Fig. 5—*Macropus agilis*, left M_{3-4} of NMV P29550a, level IV; a, labial; b, occlusal; and c, lingual views; all x 2.

that the late Pleistocene Dry Creek specimens are larger. The sample sizes are admittedly small and for this reason it is unwise to place too much emphasis on these differences. The dimensions of the Dry Creek specimens do, however, fall within the range of the large sample of *M. agilis* from Queensland described by Bartholomai (1971, p. 11). For this reason I refer the Dry Creek specimens to the living species *M. agilis*.

The relative abundance of *M. agilis* in the Dry Creek Local Fauna indicates that a large population of this species was present in

TABLE 7
Dimensions of the cheek teeth of *Macropus agilis*

Specimen	P2		DP3			P3			M1			M2			M3			M4		
	L	MW	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW
Upper																				
P29579 (VI)	–	–	–	–	–	9.8	4.0	5.0	–	–	–	9.8	7.7	7.7	–	–	–	–	–	–
Lower																				
P29549 (IV)	–	–	–	–		–	–	–	–	–	–									
P29550 (IV) (left)	–	–	–	–		–	–	–	–	–	–	9.7	–	6.2	10.5	6.7	6.7	–	–	–
									–	–	–	–	–	6.6	10.6	6.8a	6.8	11.3	6.8	6.1
P29550 (IV) (right)	–	–	–	–	–	7.8	2.5	3.4	–	–	5.6	–	6.0	6.4	–	6.7	–	–	–	–
P29575 (V)	–	–	–	–	–	–	–	–	9.0	5.4	6.1	9.8	6.0	6.4	–	–	–	–	–	–
P29576 (V)	6.6	3.5	7.8	4.2	4.7	–	–	–	8.8	5.1	5.4	–	–	–	–	–	–	–	–	–
P29603 (VII)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10.6	6.7	6.4
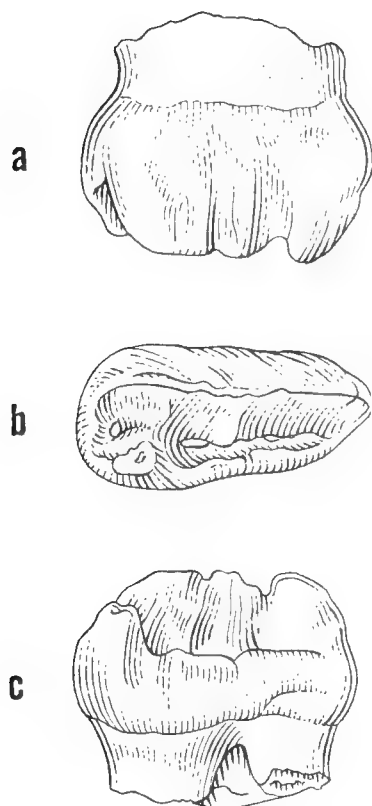
Fig. 6—*Macropus agilis*, right P^3, NMV P29579, level VI; a, labial; b, occlusal; and c, lingual views; all x 3.

Fig. 7—*Macropus titan*, left M$_{3-4}$ of NMV P29524, level III; a, labial; b, occlusal; and c, lingual views; all x 1½.

southern Victoria in late Pleistocene time. The absence of this species in Victoria today presents a problem because other macropods in the Dry Creek Local Fauna which are represented by living forms (*M. rufogriseus* and *M. titan*) are the dominant macropods in the Dry Creek area today. The factor(s) responsible for the post-Pleistocene change in distribution of *M. agilis* is presently unknown.

Macropus titan Owen, 1838

Macropus titan, the most abundant species in the fauna, is represented by a minimum of 13 individuals, accounting for 40% of the individuals in the fauna (Table 8). Dentitions of this species were recovered at all levels except level I (Fig. 7).

In Fig. 9 Dry Creek specimens are compared with a sample of *M. titan* from Lake Colongulac, Vict., showing that there is nearly complete overlap in the range of the two

samples. In linear dimensions of M$_3$, *M. titan* is intermediate in size between the smaller living species *M. giganteus* and the larger extinct late Pleistocene species *M. ferragus*.

Of the four complete metatarsal IVs listed in Table 9, two (P29534, P29535) are similar in size and are significantly smaller than the other two (P29556, P29589). I attribute these differences to sexual dimorphism with the smaller specimens representing females and the larger the males (Fig. 8).

Macropus faunus DeVis 1895 and *Macropus magister* DeVis 1895 are recognized as junior synonyms of *M. titan* (Tedford 1967). The specimen figured by Tedford (1967, Fig. 27a) and referred to *Macropus birdselli* is also referable to *M. titan*.

M. titan is the most widely distributed of the late Pleistocene macropod species and occurs in almost every late Pleistocene deposit studied. It is typically the most abundant species in late Pleistocene deposits in Vict. (Lake Colongulac), E. N.S.W. (Wellington Caves), and SE. Qd. (E. Darling Downs). At Lake Victoria in SW. N.S.W., however, *M. titan* is less abundant than the larger grazing macropod *M. ferragus* (Marshall 1973). *M. titan* was

TABLE 8

Dimensions of cheek teeth of *Macropus titan*

| Specimen	P3			M1			M2			M3			M4		
	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW
Upper															
P29537 (IV)	-	-	-	14.2	-	-	15.5	12.0	10.3	-	-	-	-	-	-
P29538 (XI)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P29606 (VII)	10.1	3.6	5.0	12.3	9.7	-	14.6	-	12.8	16.4	13.5	13.5	17.3	13.8	13.2
P29611 (VIII)	-	-	-	-	-	-	-	-	-	16.8	13.5	13.3	17.0	14.8	13.7
P29626 (IX)	-	-	-	-	-	-	15.3	-	-	-	-	-	17.4	14.7	14.1
Lower															
P29524 (III)	8.0	3.5	-	-	-	-	15.7	-	10.2	17.4	11.4	10.5	18.0	10.0	-
P29525 (III)	-	-	4.2	-	-	-	16.0	-	10.3	17.1	11.2	10.4	-	-	-
P29528 (XI)	-	-	-	-	-	-	-	-	-	-	-	-	17.6	11.6	-
P29529 (XI)	-	-	-	-	-	-	-	-	-	-	-	-	19.0	9.9	9.5
P29531 (II)	-	-	-	-	-	-	-	-	-	16.4	9.9	9.2	-	-	-
P29552 (V)	-	-	-	-	-	-	-	-	-	-	-	-	17.2	10.3	9.3
P29553 (V)	-	-	-	-	-	-	-	-	-	-	-	-	17.0	9.9	9.3
P29580 (VI)	-	-	-	-	-	-	13.8	-	9.5	15.5	9.5	9.4	17.1	-	-
P29581 (VI) (right)	-	-	-	-	-	-	-	-	-	16.9	10.7	10.7	18.9	-	11.2
P29581 (VI) (left)	-	-	-	-	-	-	-	-	-	17.0	-	-	18.7	-	-
P29582 (VI)	-	-	-	13.2	7.7	8.2	15.3	9.1	-	17.0	9.7	9.3	-	-	-
P29583 (VI)	-	-	-	14.0	8.0	8.3	-	8.0	-	-	-	-	-	-	-
P29584 (VI)	8.6	3.1	4.2	-	-	-	15.4	9.7	-	-	-	-	-	-	-
P29600 (VII)	-	-	-	13.0	-	8.7	-	-	9.8	17.0	11.6	11.0	17.6	11.5	10.7
P29602 (VII)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P29609 (VIII)	-	-	-	-	-	-	-	-	-	-	-	-	17.5	11.6	10.7
P29610 (VIII)	-	-	-	-	-	-	-	-	-	17.0	11.3	10.8	18.4	10.6	10.5
P29624 (IX)	-	-	-	-	-	-	-	-	-	-	-	-	18.2	11.0	-
P30714 (III)	-	-	-	-	-	-	16.0	-	10.4	-	-	-	-	-	-
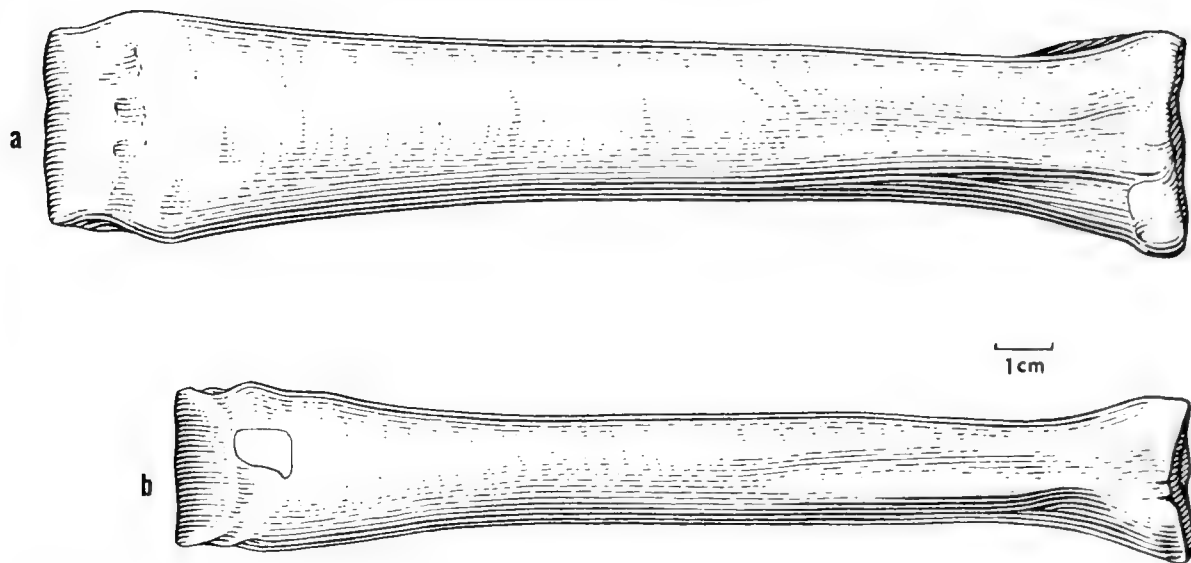
Fig. 8—*Macropus titan*, a, left metatarsal IV (male?), NMV P29556, level V, dorsal view; b, left metatarsal IV (female?), NMV P29534, level IV, dorsal view.

probably a woodland-savannah species and occupied a niche which was probably identical to that of *M. giganteus* today (see below).

M. titan appears to represent a 30% larger late Pleistocene form of *M. giganteus*. The only consistent difference between these species is in the superior size of the former. *M. titan* occurs in deposits of late Pleistocene age and older, typically in association with extinct megafaunal species of *Thylacoleo, Diprotodon, Sthenurus, Procoptodon,* and *Protemnodon,* to name just a few. *M. giganteus* is found in younger late Pleistocene deposits ($< 20,000$ yr B.P.) and never occurs in direct association with extinct megafaunal species or with *M. titan*. There is also no evidence of temporal overlap in the occurrence of these species. It thus appears most logical to regard *M. titan* as the larger late Pleistocene ancestor of *M. giganteus*. This lineage represents the fourth example of late-Pleistocene dwarfing in the fauna (see Discussion).

A large number of postcranials belonging to a large species of *Macropus* are represented in the Dry Creek collection. Except for the single questionable specimen referred to *M.* cf. *ferragus* from level III (P30716) (see below) there is no other evidence that this species is present in the fauna. For this reason the post-
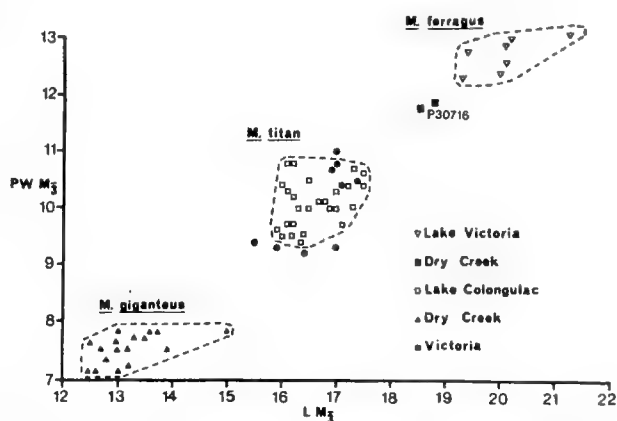
Fig. 9—Scatter diagram showing relationship of L M_3 and PW M_3 of a living sample of *Macropus giganteus* from Victoria, a fossil sample of *M. titan* from Lake Colongulac, Vict., a fossil sample of *M. ferragus* from Lake Victoria, N.S.W., and specimens referable to *M. titan* and *M.* cf. *ferragus* from Dry Creek.

cranials are assigned with relative certainty to *M. titan*.

Macropus cf. *ferragus* Owen, 1874

An associated left and right ramus (P30716) from level III may be referable to this species (Table 10). The Dry Creek specimen is compared in Fig. 9 with a sample of *M. ferragus* from Lake Victoria, N.S.W., *M. titan* from

TABLE 9
Dimensions of macropodid metatarsals and phalanges

Specimen	L	PB	PD	DB	DD
Macropus titan					
Metatarsal IV					
P29533 (XI)	-	35.0	32.5	-	-
P29534 (IV)	177.0	29.8	26.3	29.5	21.8
P29535 (IV)	178.0	30.6	27.5	31.0	23.2
P29556 (V)	198.0	40.4	32.4	39.2	26.8
P29558 (IV)	-	31.3	28.5	-	-
P29589 (VI)	207.0	39.0	28.0	39.6	28.3
P29591 (VI)	-	31.0a	26.0	-	-
P29633 (X)	-	33.0	27.8	-	-
Proximal Phalanx Digit IV					
P29518 (III)	29.7	29.5	25.2	26.5	17.0
P29560 (V)	-	-	-	20.1	13.1
Medial Phalanx Digit IV					
P29520 (III)	42.4	26.4	20.4	21.5a	13.0a
P29612 (VIII)	41.4	27.6	19.3	-	13.6
Metatarsal V					
P29557 (V)	156.0	14.8	18.4	18.6	18.7
P29605 (VII)	187.0	21.4	29.5	22.5	23.7
P29633 (X)	-	17.6	20.9	-	-
Macropodid					
Proximal Phalanx Digit IV					
P29539 (IV)	38.3	18.4	13.7	14.6	10.3
Metatarsal IV					
P29618 (VIII)	80.0	13.6	12.0	13.1	10.0
P30722 (IV)	132.4	22.5	19.2	20.8	14.4
Metatarsal V					
P29544 (IV)	117.5	11.3	14.0	14.6	13.2
P29569 (V)	-	-	-	13.4	13.0
P29618 (VIII)	71.0	7.6	9.3	9.7	11.0
Protemnodon sp.					
Metatarsal IV					
P29527 (III)	136.5	35.8	30.8	40.2	24.0
P29625 (IX)	118.0	-	31.2	-	-
P29632 (X)	-	37.0	32.5	-	-

Lake Colongulac, Vict., and an extant sample of *M. giganteus* from Victoria. In size of M_3, P30716 is closest to the *M. ferragus* sample, falls well outside the range of the *M. titan* sample and is considerably larger than *M. giganteus*. In addition to size, P30716 agrees best with the *M. ferragus* specimens in tooth morphology. As in *M. ferragus* there is a large pit on the posterior face of the hypolophid. The lower molars of specimens referable to *M. titan* typically have a small pit in this same area which is consistently present but never large or developed to the degreee found in *M. ferragus*. The possibility of P30716 representing a variant individual of *M. titan* is not dismissed. The problem of assigning P30716 to *M. titan* or *M. ferragus* with certainty reflects the close similarity in molar tooth morphology of these species. P30716 possibly represents the first reported occurrence of *M. ferragus* in Victoria.

TABLE 10

Dimensions of the cheek teeth of *Macropus* cf. *ferragus*

Specimen	M3		M4		
	L	PW	L	AW	PW
P30716 (III) (left)	18.8	11.9	18.7	12.4	10.6
P30716 (III) (right)	18.6	11.8	18.8	12.8	10.5

The type locality of *M. ferragus* is the late Pleistocene fluviatile deposits of the E. Darling Downs, SE. Qd. *Macropus gracilis*, also from the E. Darling Downs, is recognized as a junior synonym of *M. ferragus* (Tedford 1967). As in the Dry Creek Local Fauna *M. titan* is the most abundant macropod in the E. Darling Downs collections whereas *M. ferragus* is uncommon. Remains of *M. ferragus* are abundant at Lake Menindee (Tedford 1967) and Lake Victoria (Marshall 1973) in SW. N.S.W. At Lake Victoria *M. ferragus* is more abundant than *M. titan*. *M. ferragus* was predominately a savannah-grassland species and is the largest grazing species of macropod known.

TABLE 11

Dimensions of the cheek teeth of *Zygomaturus trilobus*

Specimen	P_3			M_1			M_2			M_3			M_4		
	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW	L	AW	PW
P29514 (I) (left)	19.9	15.0	17.0	30.0	23.0	24.3	-	-	-	-	-	33.1	-	-	-
P29514 (I) (right)	19.4	14.1	15.8	31.0	24.8	24.6	36.7	28.9	28.7	43.0	35.5	33.2	47.6	37.6	32.3
P29515 (II)	-	-	-	-	-	-	-	28.1	29.7	-	-	-	-	-	-

Family Diprotodontidae

Zygomaturus trilobus Macleay, 1857

A well preserved mandible (P29514) found in level I and an isolated M_2 (P29515) from level II, represent a minimum of two individuals (Table 11). Postcranials of a diprotodontid were found in levels VIII and XI (Table 12). There is no duplication among these elements suggesting that they may all have come from a single individual.

The podial elements were compared with those of *Diprotodon optatum* figured by Stirling and Zietz (1899), and it is evident that they are not referable to that species. They are probably referable to *Zygomaturus trilobus*, the only diprotodontid so far known with certainty from the fauna. Gill's (1967) record of *Diprotodon* remains in this fauna was based on these specimens.

TABLE 12

Dimensions of metatarsals of

Zygomaturus trilobus

Specimen	L	PB	PD	DB	DD
P29619 (VIII)	90.0	37.0	41.0	39.5	32.9
P29620 (VIII)	90.5	28.3	45.2	30.8	33.6

2. Doutta Galla Silt (Maribyrnong Local Fauna)

Geology

Disconformably overlying the "D Clay" containing the Dry Creek Local Fauna at the Keilor Cranium Site is the Doutta Galla Silt. The Doutta Galla Silt consists of "basal gravels three to four feet thick (basalt, sandstone, quartz, and mudstone) passed up through two to three feet of medium to fine quartz sands to 20 feet of yellowish-brown to dark grey, very fine sands and silts which form the main body of the terrace" (Bowler 1970, p. 19). "Gill (1953a, 1957) has equated the sediments of the Braybrook terrace with those of the Keilor Terrace . . . The sediments of these terraces have been formally defined as the Doutta Galla Silt, for which the type locality is located at the Dry Creek section (Gill 1962)" (Bowler *ibid*, p. 18). The fauna

from the Doutta Galla Silt from the Keilor Cranium Site, Braybrook, and Green Gully is collectively described here as the Maribyrnong Local Fauna (see Appendix 2).

Age

Bowler (1970, p. 43) noted that "deposition of the Keilor Terrace silts [began] at approximately 18,000 yr B.P. This situation is similar to that reported from the excavations of A. Gallus at the cranium site . . . The independent radiocarbon dates from other sites confirm the validity of the chronological sequence outlined above". An 18,000 yr B.P. date is accepted here as the basal age of the Doutta Galla Silt.

The Fauna

Six species of mammals are represented in the fauna: *Vombatus ursinus*, *Macropus giganteus*, *Megaleia rufa*, *Mastacomys fuscus*, *Pseudomys* cf. *gracilicaudatus*, and *Pseudomys* cf. *australis*, all represented by living populations. The fauna is modern in all respects.

Systematics Review

Family Vombatidae

Vombatus ursinus (Shaw, 1800)

Vombatus ursinus is represented by a single mandible (P30724). This species has been discussed above under the Dry Creek Local Fauna.

Family Macropodidae

Megaleia rufa (Desmarest, 1822)

This species is represented by a minimum of four individuals and is the most abundant species in the fauna (Table 13). The L M_3 and PW M_3 of the Dry Creek specimens are compared in Fig. 11 with an extant sample of *Megaleia rufa*, *Osphranter robustus*, and *Macropus giganteus*. In size, the Dry Creek specimen falls well within the range of the *M. rufa* sample.

On lower molars of *M. rufa* the posterior face of the hypolophid is plain and the entoconid is set more posteriad from the metaconid than the hypoconid is from the protoconid (Fig. 10). In *O. robustus* a faint diagonal

groove is present on the posterior face of the hypolophid, whereas *M. giganteus* typically has a well developed (although usually small) vertical groove on the hypolophid which appears as a well defined pit on the occlusal surface in worn teeth. In both *O. robustus* and *M. giganteus* the hypolophid and protolophid are subparallel (Tedford 1967, pp. 113-114).
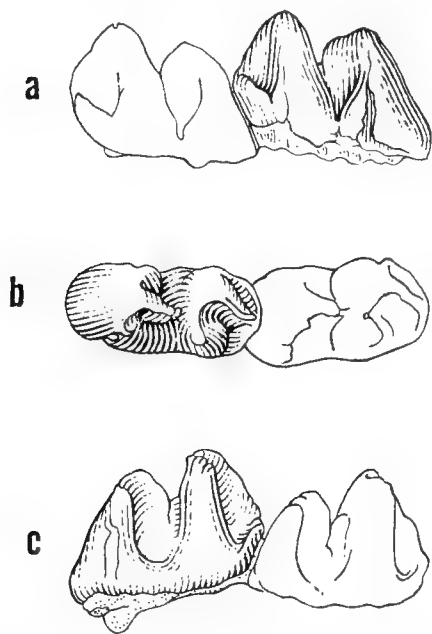
Fig. 10—*Megaleia rufa*, left M_{3-4}, NMV P30750a, Doutta Galla Silt; a, labial, b, occlusal, and c, lingual views; all x 1¼.

Fossil remains of *M. rufa* have been recorded in Victoria from the outlet of Lake Gnapurt to Lake Corangamite. A C_{14} date of 4,550 ±120 (GaK-2518) yr B.P. was obtained from associated *Coxiella* shells (Gill 1971). There is also a specimen of *M. rufa* (P30216) from a bone bed on the E. shore of Lake Werranganuck. Gill (1971, p. 76) reports that a C_{14} date of 25,300±1,200 (GaK-986) yr B.P. was obtained on *Coxiella* shells from this bone bed making the *M. rufa* specimen (P30216) late Pleistocene in age and roughly equating this deposit with the "D Clay". P30216 is compared in Fig. 11 with an extant sample of *M. rufa* and specimens referable to *M. rufa* from the Maribyrnong Local Fauna. The larger size of the Lake Werranganuck specimen

suggests that larger forms of *M. rufa* lived in late Pleistocene time. This species apparently underwent a late Pleistocene dimunition in body size similar to that occurring in the *Macropus titan-M. giganteus* lineage. Average individuals in living populations of *M. rufa* are about 25-30% smaller than individuals in the late Pleistocene, i.e. >20,000 yr B.P.

As a living species *M. rufa* has been recorded in Victoria from Benetook and Ned's Corner in the NW. corner of the State (Wakefield 1966, p. 632).
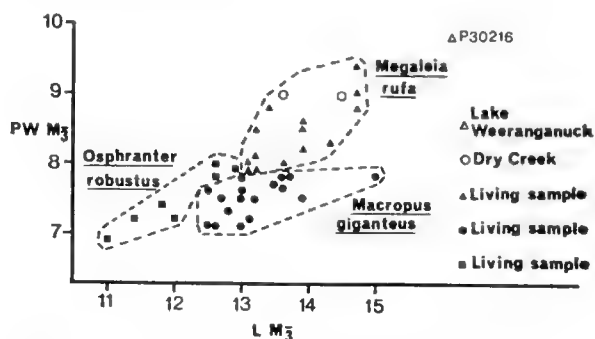
Fig. 11—Scatter diagram showing relationship of L M_3 and PW M_3 of living samples of *Megaleia rufa, Osphranter robustus,* and *Macropus giganteus,* a fossil sample of *Megaleia rufa* from the Doutta Galla Silt, and a fossil specimen of *M. rufa* from Lake Weeranganuck, W. Victoria.

Macropus giganteus (Shaw, 1790)

Two specimens represent a minimum of one individual of this species (Table 13). The relationship of *M. giganteus* to *M. titan* was discussed under the Dry Creek Local Fauna. The Keilor specimens of *M. giganteus* are indistinguishable in size and tooth morphology from extant specimens.

As a living species *M. giganteus* is abundant in sclerophyll forest, common in woodland and rare in plains habitat (Marlow 1958). That the species is presently found in such diverse habitats reduces its usefulness as an indicator of paleohabitats.

Order Rodentia

Family Muridae

Mastocomys fuscus Thomas, 1882

This species is represented by a single specimen (P30906) consisting of the greater part

of a skull and associated fragment of the left ramus with M_{1-2} (Table 14).

Approximately 4% of the specimens of *M. fuscus* studied by Wakefield (1972) had supernumerary cusps on the lingual side of the upper molars. There is no trace of these cusps in P30906. P30906 is the specimen recorded by Gill (1955a,b) as *Rattus* cf. *assimilis*.

At lower altitudes on the Australian mainland this species lives in "wet sclerophyll forest with dense undergrowth containing ferns, shrubs, and grasses" (Ride 1970, p. 152).

TABLE 13

Dimensions of the lower cheek teeth of *Macropus giganteus* and *Megaleia rufa* from the Doutta Galla Silt

Specimen	DP_3			M_1			M_3		M_4		
	L	AW	PW	L	AW	PW	L	PW	L	AW	PW
Macropus giganteus											
P30750b	-	-	-	-	-	-	-	-	15.8	9.7	8.6
Megaleia rufa											
P30750a	-	-	-	-	-	-	13.6	9.0	-	-	-
P30730	-	-	-	-	-	-	14.5	9.0	-	-	-
P30751	9.0	4.7	5.7	11.2	6.5	6.9	-	-	-	-	-

TABLE 14

Cheek teeth dimensions of the rodents from the Doutta Galla Silt

Specimen	M1		M2		M3		M1-3
	L	MW	L	MW	L	MW	L
Upper cheek teeth							
Mastacomys fuscus							
P30906 (left)	3.8	3.2	2.6	3.1	2.9	2.4	9.9
P30906 (right)	3.8	3.3	2.6	3.1	2.9	2.4	9.8
Pseudomys cf. *australis*							
P15773 (left)	2.7	2.0	1.8	1.8	1.4	1.3	5.9
P15773 (right)	2.7	2.0	1.7	1.8	1.4	1.4	5.9
Lower cheek teeth							
Mastacomys fuscus							
P30906 (left)	3.9	2.8	2.6	2.7	-	-	-
Pseudomys cf. *gracilicaudata*							
P30907	2.3	1.7	1.8	1.7	1.3	1.2	5.5
P30908	2.5	1.7	1.9	1.7	-	-	-
Pseudomys cf. *australis*							
P15773 (left)	2.8	1.7	1.7	1.8	1.2	1.4	5.9

That this animal was considered to be extinct only four decades ago (Wood-Jones 1923-25) indicates that there is still much to be learned about its biology before palaeontologists can use it in palaeoecological considerations.

Pseudomys cf. australis Gray, 1832

and

Pseudomys cf. gracilicaudatus (Gould, 1845)

The genus *Pseudomys* is represented by three specimens, representing two species (Table 14). These have been identified by Mr. J. A. Mahoney as *Pseudomys* cf. *gracilicaudatus* (P30907, P30908) and *P.* cf. *australis* (P15773).

"Native cats"

Gill (1955a,b) reported the presence of "native cats" in the Doutta Galla Silt, but I have not been able to relocate the specimens upon which this was based. "Native cat" is the colloquial name generally applied to one of the four species of *Dasyurus* (*D. hallucatus, D. geoffroyi, D. maculatus, D. viverrinus*) which live today on the Australian mainland and Tasmania. *D. maculatus* and *D. viverrinus* occur in the Dry Creek area today and are abundant in Holocene and late Pleistocene deposits in S. Victoria. The presence of either or both of these species in the Maribyrnong Local Fauna would not be unexpected.

Discussion

The major reservation which must be immediately recognized in comparing the Dry Creek Local Fauna with the Maribyrnong Local Fauna is that the sample size from the latter is extremely small. For this reason larger sample sizes from the Doutta Galla Silt will surely result in expansion of the present study; the basic theme of late Pleistocene faunal succession as outlined below should, however, remain unchanged.

In the time interval between deposition of the "D Clay" and the Doutta Galla Silt two major faunal changes occurred: (1) many of the megafaunal species became extinct (i.e. *Thylacoleo carnifex, Protemnodon anak, P. brehus, Macropus ferragus* and *Zygomaturus trilobus*), and (2) some megafaunal species

associated with the now extinct megafaunal species underwent a reduction in body size giving rise to smaller living forms. Some of these smaller living forms are presently recognized as distinct species (i.e. *Macropus giganteus* represents a smaller living form of *M. titan*; *Sarcophilus harrisii* represents a smaller living form of *S. laniarius*).

It is a well established fact that many living species of both carnivorous and herbivorous mammals are represented in late Pleistocene deposits by populations which are on the whole larger in absolute body size. This reduction in body size has been discussed by various workers under the heading of "post-Pleistocene dwarfing" and has been shown to occur on a world wide scale (Hooijer 1950, Kurten 1959, Wen-Chung 1963). Hooijer (1950) has referred to this dwarfing as "a sort of general evolutionary trend that is going on in the Quaternary". Kurten (1959, 1968 and references) has established the present of post-Pleistocene dwarfing in many European and Asian mammals with many of the lineages showing a 25-30% reduction in body size. As seen in the present study this dimunition in body size is not restricted to post-Pleistocene time but occurs also in the late Pleistocene. I have, therefore, used the term "late-Pleistocene dwarfing" throughout the text in reference to this phenomena in the Australian marsupials.

The presence of late-Pleistocene dwarfing has not been well established for Australian marsupials although I have found it to occur in a large number of species. These include the following species or lineages as the case may be (where the late Pleistocene forms are recognized as distinct species they are listed first): *Macropus titan-M. giganteus, Macropus siva-M. agilis* (probably), *Megaleia rufa, Osphranter cooperi-O. robustus, Wallabia vishnu-W. bicolor, Thylacinus cynocephalus, Sarcophilus laniarius- S. harrisii*, and possibly *Dasyurus maculatus. Macropus rufogriseus* has remained unchanged in size and tooth morphology from the late Pleistocene to the present. *M. rufogriseus* is also the smallest macropod species in the Dry Creek Local Fauna and it is interesting and probably significant that larger macropod species experi-

enced either a late-Pleistocene dimunition in body size (probably in the lineage *M. siva-M. agilis* and definitely in the lineage *M. titan-M. giganteus*), while still larger body species became extinct (i.e. *Protemnodon anak, P. brehus, Macropus ferragus*). It would thus appear that the late-Pleistocene fate of a species was determined to a large extent by its absolute body size, as reflected in tooth dimensions.

The immediate problem arising from recognition of late-Pleistocene dwarfing is how to treat the populations of each species through time. Are the larger late Pleistocene forms specifically distinct, subspecifically distinct, or taxonomically indistinct from the smaller living forms? Some of the lineages show size differences of 5%, others 30%. Can all of these lineages be treated collectively or is it best to treat each lineage separately depending upon the amount of dwarfing involved? An attempt to answer these questions must be based on more extensive collections and larger sample sizes than those constituting the faunas described here.

Kurten (1959) considered the populations he studied which showed post-Pleistocene dwarfing to be distinct at the subspecific level. These species differed by a magnitude equal to the differences which occur in the Australian species. If Kurten's example is followed then such late Pleistocene species as *Macropus titan* would be regarded as subspecies of the living *M. giganteus* (i.e. *Macropus giganteus titan*). Such taxonomic changes are not proposed here although the option is made available for future studies.

The term megafauna as used in this study includes those large body sized species of mammal which occur in late Pleistocene deposits >20,000 yr B.P. As shown above, the megafauna is composed of two very distinct groups: (1) species now extinct, and (2) species which have undergone a late-Pleistocene dimunition in body size. It is thus necessary to indicate which of these groups is being considered when using the term megafauna; if no distinction is made it must be assumed that both groups are being considered collectively.

In late Pleistocene faunas >20,000 yr B.P. and represented by large sample sizes, both megafaunal groups occur together. There are no faunas to my knowledge which are composed of only one of these groups. Based on this evidence it may be induced that where extinct megafaunal species are found there will also be found larger forms of living species; where living species occur which are of their present size there will be no extinct megafaunal species found. I know of no exceptions to this generalization although it must be kept in mind that within the time interval between extinction of part of the megafauna and dwarfing of part of the megafauna these groups may not show complete overlap. Deposits showing this transition are presently unknown.

At Lake Menindee, N.S.W., a C_{14} date of $26,300 \pm 1,500$ yr B.P. was obtained on charcoal from an Aboriginal oven associated with the remains of the extinct macropod *Macropus ferragus* (Tedford 1967). At Lake Victoria, N.S.W., an 18,000 yr B.P. date is tentatively recognized as representing a possible terminal date for extinction of late Pleistocene megafaunal species (Marshall 1973). These studies complement the age and faunal composition of the Dry Creek and Maribyrnong Local Faunas respectively.

Thorne (1972) described the late Pleistocene fauna from Koonalda Cave, S.A., collected from red, water-laid deposits "which are approximately 20,000 yr B.P. old". All of the species present in the fauna are represented by living forms; no extinct megafaunal species or larger forms of living species are present. The fauna is modern in all respects. Thorne's study upholds the conclusions reached by Jones (1968, p. 203) that "where fauna is found in archaeological sites spanning the last 20,000 yr it is modern".

On the bases of these data it appears that extinction of late Pleistocene megafaunal species and attainment of a fauna of modern aspect occurred in the time interval between 20,000-25,000 yr B.P. In addition, it is concluded that late Pleistocene extinctions and late-Pleistocene dwarfing are correlative and

that these phenomena may possibly have been caused by a common, cryptic, factor(s).

Acknowledgements

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Appendix 1

Dry Creek Local Fauna

Level

I. *Gravel layer 1, D excavation*
   (a) *Zygomaturus trilobus* P29514, mandible.

II. *X clay under L gravel*
   (a) *Zygomaturus trilobus* P29515, isolated M_2.
   (b) *Macropus titan* P29644, left ramus; P29531, right ramus with M_{3-4}.
   (c) macropodid P29516, fragment of right ramus of medium-sized macropod, with roots of M_{2-4}?; P29517, distal end of humerus of large macropod.

III. *D excavation, D clay*
   (a) *Perameles nasuta* P29634, associated right ramus fragment with P_1-M_3 and associated left maxillary fragment with M^{2-3}.
   (b) *Vombatus ursinus* P23026, mandible; P29519, fragment of right ramus.
   (c) *Protemnodon brehus* P29522, fragment of right maxillary with M^{2-4}.
   (d) *Protemnodon* sp. P29527, left metatarsal IV with proximal end of metatarsal III, and left tibia.
   (e) *Macropus titan* P29518, proximal phalanx digit IV; P29520, medial phalanx digit IV; P29521, fragment of right maxillary with M^{2-4}; P29523, right ramus; P29524, left ramus with M_{1-4}; P29525, right ramus with P_3, M_{1-4} (associated with P29524); P29526, tip of right lower incisor; P30904, right ramus; P30714, right ramus; P30719, proximal end of right metatarsal IV; P30720, proximal end of right metatarsal IV.
   (f) *Macropus* cf. *ferragus* P30716, left and right ramus.
   (g) macropodid P30718, distal end of metatarsal IV; P30721, proximal end of left metatarsal IV of medium-sized macropod.

IV. *A clay, level 4*
   (a) *Sarcophilus laniarius* P29547, shaft of left humerus.
   (b) *Vombatus ursinus* P29548, left ilium region of acetabulum.
   (c) *Macropus titan* P29534, left metatarsal IV; P29535, right metatarsal IV; P29537, left maxillary fragment with M^{1-2}; P29541, right astragalus; P29558, proximal end of right metatarsal III and IV; P30715, left ramus; P30726, calcaneum; P29560, proximal phalanx digit IV.
   (d) *Macropus agilis* P29549, left ramus; P29550, associated left and right rami; P29551, fragment of left ramus.
   (e) *Macropus rufogriseus* P30725, left ramus; P29577, right ramus.
   (f) macropodid P29532, distal end of right humerus; P29536, shaft of right humerus; P29539, proximal phalanx of digit IV; P29542, last thoracic or first lumbar vertebra; P29543, left ilium fragment; P29544, left metatarsal V; P29568, right

metatarsal V; P30722, left metatarsal IV; P29563, fragment of right scapula; P29566, fragment of right humerus; P29598, distal end of right femur.

V. *A clay, level 3*
(a) *Sarcophilus laniarius* P29631, right maxillary fragment with P³-M¹.
(b) *Protemnodon anak* P29554, left ramus with P₃, M₁₋₄; P29555, right M₃.
(c) *Macropus titan* P29552, fragment of right ramus with M₄; P29553, left ramus with M₃₋₄; P29556, left metatarsal IV; P29557, left metatarsal V; P29564, right calcaneum.
(d) *Macropus agilis* P29575, left ramus; P29576, right ramus.
(e) *Macropus rufogriseus* P29578, right maxillary fragment with M²⁻⁴.
(f) macropodid P29559, acetabular region of left innominate; P29561, left cuboid; P29562, right scapula fragment; P29567, caudal vertebrae; P29569, distal end of left metatarsal V; P29570, proximal end of right ulna; P29571, distal end of right humerus; P29572, right calcaneum; P29573, left acetabular portion of innominate; P30727, proximal end of left metatarsal IV; P30728, fragment of right innominate.

VI. *A clay, level 2*
(a) *Thylacinus cynocephalus* P29588, left humerus.
(b) *Sarcophilus laniarius* P29587, left maxillary fragment with M¹⁻⁴.
(c) *Protemnodon* sp. (probably *P. brehus*) P29586, isolated right lower incisor.
(d) *Macropus titan* P29580, left ramus; P29581, right and left ramus; P29582, isolated right M₃; P29583, left ramus; P29584, right ramus; P29589, right metatarsal IV; P29590, left metatarsal V; P29591, left metatarsal IV.
(e) *Macropus agilis* P29579, right P³, M¹⁻².
(f) *Marcoput rufogriseus* P29585, series of upper incisors.
(g) macropodid P29592, lumbar vertebra; P29593, vertebra; P29594, caudal vertebra; P29595, left acetabular portion of innominate; P29596, portion of right ilium; P29597, portion of right scapula.

VII. *A clay, level 1*
(a) *Macropus titan* P29600, left ramus; P29602, left ramus; P29605, left metatarsal V; P29606, right maxillary fragment; P29607, left calcaneum; P29608, associated left calcaneum and astragalus.
(b) *Macropus agilis* P29603, left ramus with M₁.
(c) *Macropus rufogriseus* P30905, left ramus.

VIII. *A clay, level 1a*
(a) diprotodontid (probably referable to *Zygomaturus trilobus*) P29619, right metatarsal V; P29620, right metatarsal IV; P29621, right cuboid; P29622, right ectocuneiform; P29623, right navicular.
(b) *Macropus titan* P29609, right ramus; P29610, isolated left M₄; P29611, associ-

ated fragments of upper dentition; P29612, medial phalanx of digit IV; P29613, associated left and right innominate.
(c) macropodid P29614, fragment of right scapula; P29615, fragment of right innominate; P29616, caudal vertebra; P29617, right innominate; P29618, right metatarsal IV and V (both large and small species of macropod are included in this group).

IX. *Excavation Y, various levels*
(a) *Protemnodon brehus* P29628, right ramus.
(b) *Protemnodon* sp. P29625, left metatarsal IV.
(c) *Macropus titan* P29624, right ramus; P29626, right maxillary fragment; P29627, left maxillary fragment; P29629, fragment of right tibia.
(d) In addition to the above there are fragments of a large pelvis, a medium-sized pelvis, a medial phalanx of digit IV, and several vertebrae of macropods. These were not catalogued because of their fragmentary condition.

X. *KA Excavation 1963*
(a) *Protemnodon* sp. P29632, right metatarsal IV.
(b) *Macropus titan* P29633, right metatarsal IV and V.
(c) macropodid (small species) P29630, isolated right lower incisor.

XI. *KAA, lowest level*
(a) *Thylacoleo carnifex* P29545, right maxillary fragment with lower edge of orbit, and anterior root of P³.
(b) *Macropus titan* P29528, right ramus with M₂₋₄; P29529, left ramus with M₂₋₃ broken, M₄ complete; P29530, left ramus with M₃₋₄; P29533, proximal end of right metatarsal IV; P29538, left maxillary fragment with M¹⁻⁴; P29540, right astragalus.
(c) diprotodontid (probably referable to *Zygomaturus trilobus*) P30723, right calcaneum.

KAA, middle level
(a) diprotodontid P29599, shaft of left humerus.
(b) *Macropus rufogriseus* P29574, right ramus.
(c) macropodid P29565, fragment of right humerus.

KAA, highest level
(a) *Protemnodon anak* P29604, associated left and right ramus.
(b) *Macropus titan* P29601, left ramus.

Appendix 2

Maribyrnong Local Fauna

(a) *Vombatus ursinus* P30724, mandible.
(b) *Megaleia rufa* P30730, left maxillary fragment with M²?; P30749, two lower molar fragments. This specimen was collected as float from the soil quarry in Green Gully downstream from St. Albans Road, Keilor, Victoria. P30749 and

other bones were found washed out of a bull-dozed slope in the Doutta Galla Silt where it abuts against the hillside at the southern end of the quarry (slope nearest shed). P30750a, upper molar and lower molar series (left) (M_{2-4}), and isolated left lower molar; P30751, associated with C_{14} date W169, Braybrook.

(c) *Macropus giganteus* P30752, left ramus with broken M_{2-4}; P30750b, isolated lower molar, probably M_4.

(d) *Mastacomys fuscus* P30906, partial skull with left and right M^{1-3}, associated left ramus fragment with M_{1-2}. This specimen was collected by Mr. H. E. Wilkinson, *in situ*, in the soil quarry in Green Gully, downstream from Keilor Terrace-St. Albans Road.

(e) *Pseudomys* cf. *P. australis* P15773, associated skull and postcranial fragments representing a single individual. This specimen was collected by Mr. E. D. Gill seven feet from surface and above diastema in east wall of Keilor cranium quarry.

(f) *Pseudomys* cf. *P. gracilicaudatus* P30907, left ramus with incisor, M_{1-3}; P30908, left ramus with incisor, M_{1-2}. These specimens were collected by Mr. H. E. Wilkinson 13 feet below the surface of high level terrace, in soil pit at mouth of Green Gully, Keilor.

Erratum: Fig. 9, . . . solid triangles represent extant sample of *Macropus giganteus* from Victoria, solid circles represent fossil sample of *Macropus titan* from Dry Creek (opposite as appears in the figure).

REVISION OF THE ENDEMIC SOUTHEASTERN AUSTRALIAN LIZARD GENUS *PSEUDEMOIA* (SCINCIDAE : LYGOSOMINAE)

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Summary

The type species of the genus, *Pseudemoia spenceri* (Lucas and Frost, 1894) is reviewed and *Lygosoma (Liolepisma) weekesae* Kinghorn, 1929, is placed in synonymy. A new species, *Pseudemoia palfreymani*, is described for the genus which was previously thought to be monotypic. The ecology and distribution of each species is discussed.

Introduction

Pseudemoia is the only lizard genus endemic to SE. Australia. However, the type species is poorly known, and many authors (e.g. Greer 1970) have apparently overlooked it. One of the species discussed in this paper (*P. spenceri*) is restricted to the high rainfall areas from 33°S. in New South Wales to the S. Victorian coast. The other species (*P. palfreymani* sp. nov.) is known only from Pedra Branca Rock (S. Tasmania), the southernmost and deepest-water island found on the Australian continental shelf. As seals and seabirds are the only other animals known from the island, this lizard is the southernmost terrestrial vertebrate found in Australia.

Genus **Pseudemoia** Fuhn

Pseudemoia Fuhn, I. E., 1967, *Zool. Anz.* 179: 243-247, pl. 1-2.
Type species: *Lygosoma (Emoa) spenceri* Lucas and Frost, 1894.

Fuhn (1967) differentiated this genus of skinks after examining only two specimens belonging to the type species. Fuhn's definition of the genus is basically accepted here, although examination of a large series of specimens (150) from the type species and four specimens from a new species has caused some modification.

Diagnosis. Small to moderately large skinks (snout-vent length 2·4-8·5 cm), head and body flattened, tail round. Limbs pentadactyl, well developed and overlap when adpressed. Digits not elongate, 20-28 lamellae under the fourth toe, palmar tubercles flattened. Body

scales small, smooth, dorsal and lateral scales with 3-5 very faint keels, midbody scales in 37-48 rows. Lower eyelid moveable with a well developed transparent palpebral disc surrounded by small granular scales. External ear opening moderately large with 2-4 enlarged anterior lobules. A pair of supranasal scales invariably present, separated medially by the frontonasal. A small postnasal is present, normally fused to the supranasal scale in *P. spenceri* (85% of specimens examined) but free in all *P. palfreymani* specimens examined. Prefrontals enlarged but barely contact or fail to contact along the midline. Frontoparietals separate in *P. spenceri* but fused in *P. palfreymani* (cf. Fuhn 1967, always separate). Interparietal always separate. Parietals large and meet along midline.

Pseudemoia spenceri (Lucas and Frost, 1894)
Pl. 5, fig. 2

Lygosoma (Emoa) spenceri Lucas, A. H. S., and Frost, C., 1894, *Proc. R. Soc. Vict.* 6: 81-82, pl. 2, figs. 1-1a. Zietz, F. R., 1920, *Rec. S. Aust. Mus.* 1: 213.
Lygosoma (Liolepisma) weekesae Kinghorn, J. R., 1929, *Proc. Linn. Soc. N.S.W.* 54: 32-33, 1 fig.
Leiolopisma weekesae Loveridge, A., 1934, *Bull. Mus. Comp. Zool.* 77: 360. Copland, S. J., 1947, *Proc. Linn. Soc. N.S.W.* 72: 69-72. Costin, A. B., 1954, *A Study of the Ecosystems of the Monaro Region of N.S.W.* Sydney, p. 97.
Ablepharus spenceri Smith, M. A., 1937, *Rec. Indian Mus.* 39: 213-234, pl. 4. Greer, A. E., 1970, *Bull. Mus. comp. Zool.* 139: 151-183.
?*Emoia spenceri* Worrell, E. R., 1963, *Reptiles of Australia.* Sydney, p. 44, 171, pl. 15.
Emoia spenceri Rawlinson, P. A., 1967, *Proc. R. Soc. Vict.* 80: 211-224. 1969, *ibid.* 82: 113-128.
Pseudemoia spenceri Fuhn, I. E., 1967, *Zool. Anz.* 179: 243-247, pl. 1-2. Fuhn, I. E., 1969, *Zeit.*

Zool. Syst. Evol. 7: 67-76, fig. 2. Coventry, A. J., 1970, *Mem. natn. Mus. Vict.* 31: 115-124. Rawlinson, P. A., 1971, *Proc. R. Soc. Vict.* 84: 37-51. Rawlinson, P. A., 1971, *Vict. Yearbook* 85: 11-36. Spellerberg, I. F., 1972, *Oecologia* 9: 23-46.

Type series of **Lygosoma (Emoa) spenceri** Lucas and Frost 1894

When describing this species, Lucas and Frost listed specimens in the collection of the National Museum of Victoria (hereafter NMV) from "Brandy Creek" and "Dandenong Ranges". These were located by Coventry (1970). One specimen (NMV D1824) which carries the label "Figured specimen 5/95" was designated lectotype and the other (NMV D3357) was designated as paralectotype. The remaining specimens used in the original description were in the private collections of Lucas and Frost who apparently dispersed them to various institutions. A specimen (now NMV D12555) labelled "Croajingolong" was found in Lucas's Melbourne University Zoology Department collection. Another labelled "Gisborne" and donated by A. M. S. Lucas (AM R3991) has been located in the Australian Museum, and there are two specimens in the British Museum of Natural History (BMNH 93.6.15.3-4; 1946. 8.15.81-82) donated by A. H. S. Lucas and labelled "Victoria". One of these BMNH specimens was listed by Fuhn as a syntype of *P. spenceri* (number quoted as BMNH 93.6.15.2; RR 1946. 8.15.81). All of the above specimens except those in the British Museum have been examined by the author.

Lectotype. NMV D1824. Locality: Brandy Cr., Gippsland, Vict. (Pl. 5, fig. 2). Its condition is poor because desiccated at some stage.

Description. Snout-vent length 4·1 cm. Tail (complete) 5·5 cm, 134% S-V length. Supranasals present. Small postnasal. Rostral and frontonasal in broad contact. Prefrontals narrowly separated. Frontonasal contacts anterior loreals and excludes prefrontals from supranasals. Anterior and posterior loreals large. Frontoparietals divided. Interparietal moderately large. Parietals large and contact on midline. Nuchals enlarged, two symmetrical pairs. Temporals enlarged. Four supraoculars, second

the largest. Six superciliaries (seven in Lucas and Frost). Six upper ciliaries, 13 lower ciliaries. Lower eyelid moveable, with a very large transparent palpebral disc surrounded by small granular scales. Nine upper labials, seventh enlarged and borders orbit, nine lower labials. Ear opening obvious, three slightly enlarged anterior lobules. Seven slightly enlarged preanal scales. Subdigital lamellae undivided and smooth, 20 under the fourth toe. Palmar tubercles flat, slightly rounded near base of digits. Midbody scale rows 38. Dorsal scales slightly enlarged, dorsal and lateral scales with 3-4 very faint keels. Colour of preserved specimen: Very dark brown to black above with irregular light coloured flecks. A light dorsolateral stripe passes from the nostril above the eye, over the temporal region, along the body and extends onto the tail; this line is very pronounced on the trunk. A light lateral stripe runs from the ear through the axilla to the groin. Ventral surface unmarked, off-white to light grey. Palmar surfaces light to dark grey.

Paralectotype. NMV D3357. Locality: Dandenong Ranges, Vict. Conspecific with lectotype.

Other possible syntypes examined: NMV D12555. Locality: Croajingolong, Vict. R3991 in the Australian Museum. Locality: Gisborne, Vict. Both are conspecific with the lectotype.

Type series of **Lygosoma (Liolepisma) weekesae** Kinghorn 1929 Pl. 5, fig. 3

Kinghorn listed a holotype and three paratypes from the Australian Museum. Only the holotype was listed with complete data including the registered number (AM R9745). The three paratypes were designated only by locality, collector and date of collection. All three have been located and they include a juvenile specimen (AM R563) from Mt. Kosciusko and two adults, one (AM R1860) from the Jenolan District and one (AM R6536) from Bombala in the Snowy Mts. Kinghorn mentioned in a footnote six additional specimens collected from the Jenolan district. These also have been located in the

Australian Museum and are specimens AM R9750, R9751, R26606, R26607, R26608, and R26609. All have been examined by the author.

Holotype. R9745 in the Australian Museum. Locality: Mt. Kosciusko (at c.1680 m) N.S.W. Collector: R. Helms May 1889 (Pl. 5, fig. 3). Conspecific with lectotype of *P. spenceri*. Kinghorn's description and figure of specimen inaccurate; supranasal scales present and obvious.

Paratypes. All in Australian Museum. R563 Mt. Kosciusko (at c.1680 m) N.S.W. Collector: R. Helms May 1889. R1860 Jenolan, Blue Mts. N.S.W. Collector: R. Etheridge 2 Nov. 1895. R6356 Bombala, Snowy Mts., N.S.W. No other data. All three paratypes are conspecific with lectotype of *P. spenceri*; in all supranasal scales are present and obvious.

Other specimens mentioned in description. All in Australian Museum, R9750-51, R26606-09. Jenolan District, N.S.W. Collector: H. C. Weekes 15 Feb. 1929. All six specimens are conspecific with lectotype of *P. spenceri*; in all supranasal scales are present and obvious.

Status of *Lygosoma* (*Liolepisma*) *weekesae*: This species is now placed in the synonymy of *Pseudemoia spenceri*.

Description of a series of specimens of **Pseudemoia spenceri**

In order to determine intraspecific variation in some important taxonomic characters, 150 specimens were examined in detail.

Size. Mature adults: Snout-vent length 4·1-6·5 cm, mean 5·05 cm (70 specimens). Intact tail 102-136% (mean 119%) of S-V length (20 specimens). Total length of adults with intact tails 9·5-12·6 cm, mean 11·0 cm (20 specimens). Juveniles at birth: Snout-vent length 2·4-3·0 cm, mean 2·7 cm (15 specimens). Intact tail 104-128% (mean 116%) of S-V length (8 specimens). Total length of juveniles with intact tails 5·3-6·5 cm, mean 5·9 cm (8 specimens).

Scalation. Supranasals present in all 150 specimens examined. Postnasals separate from supranasals in 22 of the 150 specimens examined (15%). Upper labial scales variable. Of the 150 specimens examined:
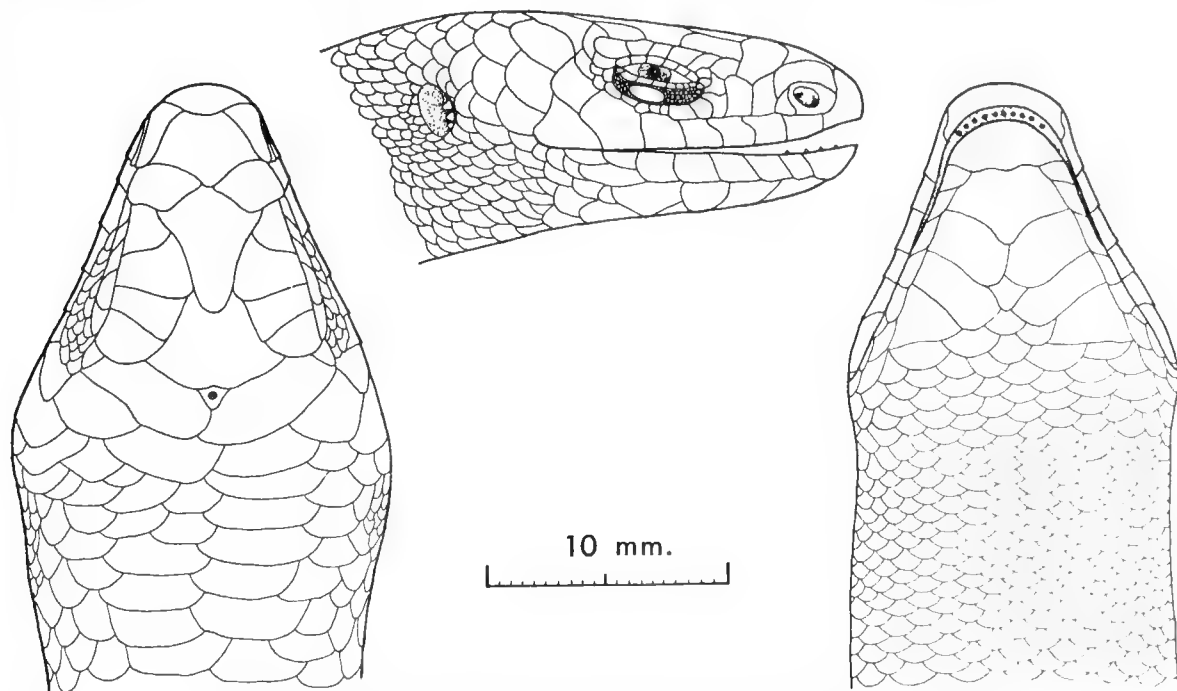

Fig. 1—Headshields of *Pseudemoia palfreymani* sp. nov. NMV D8868.

3 (2%) had 11 upper labials with 9th entering orbit.

34 (23%) had 10 upper labials with 8th entering orbit.

98 (65%) had 9 upper labials with 7th entering orbit.

15 (10%) had 8 upper labials with 6th entering orbit.

Midbody scale rows 37-48, mean 42·1, mode 43 (98 specimens).

Lamellae under the fourth toe 20-28, mean 23·6, mode 24 (98 specimens).

Colour of live specimens: Very dark brown to black above, flecked with light brown and chocolate brown spots, which may be arranged more or less in lines. Most specimens have light grey or brown dorsolateral and lateral stripes; some of these specimens also possess a wide vertebral stripe. A few specimens lack longitudinal stripes altogether. Ventral surfaces unmarked, light grey to light brown.

Other Specimens Examined. The localities and registered numbers of all other specimens of *Pseudemoia spenceri* examined are listed below. These include specimens from the author's collection (MUZD) assembled while the author was working in the Melbourne University Zoology Department, NMV specimens, and specimens in the Australian Museum, Sydney (AM).

New South Wales. (MUZD) Brady's Farm 9 km N. of Jenolan Caves (150/70, 31/71-47/71, 207/71-217/71), 12 km W. of Jenolan Caves (157/70), Tuross R. 14·5 km SSE. of Countegany (1072/65). Scammels Lookout 19·5 km SSE. of Khancoban (177/65). Sawpit Creek Kosciusko Park (17/69, 18/69), 8 km ENE. of Thredbo (400/63-411/63), Nimmitabel (403/69-409/69), Brown Mt. (97/69), 5·5 km ESE. of Brown Mt. (98/69). (NMV) Mt. Kosciusko (D16875), 3 km E. of Brown Mt. (D16875). (AM) Mt. Kosciusko 900-1500 m (R551).
Australian Capital Territory. (MUZD) Picadilly Circus, Brindabella Range (104/68), Mt. Franklin, Brindabella Range (69/64), 3 km S. of Mt. Franklin (66/64, 8/71-10/71), Mt. Ginni, Brindabella Range (16/71).
Victoria. (MUZD) 9 km SSW. of Cowombat Plain (242/69), 1·5 km NW. of Mt. Cobberas (223/69, 225/69, 230/69), 13 km W. of Mt. Cobberas (62/69-66/69), Native Dog Plain, 7 km SW. of Mt. Cobberas (61/69), 13·5 km W. of Omeo (277/63), Mt. Delegate (246/65-251/65, 281/65-283/65, 303/65, 304/65, 324/65-327/65, 330/65-332/65), 9·5 km NE. of Mt. Ellery (211/70), Bindaree Hut, 9·5 km

W. of Mt. Howitt (310/64), Delegate R. 9 km SW. of Bendock (207/65, 208/65, 258/65), Wilhelmina Falls 6·5 km SE. of Murrindindi (236/70), Mt. Bowen E. Gippsland (9/72-10/72), Murrindindi Falls 13 km SE. of Murrindindi (326/68, 327/68), Yea Rock Lookout (215/69), Lake Mountain (352/63), Kalatha Camp (323/68), 14·5 km E. of Marysville (447/63), Mt. St. Leonard (324/68-325/68), Kalorama (204/68, 178/69), 14·5 km NE. of Loch Valley Camp (241/66, 248/66-266/66, 338/66-343/66, 382/66, 507/66, 149/67-161/67), 13 km NE. of Loch Valley Camp (270/66), 12 km NE. of Loch Valley Camp (770/65, 777/65-788/65), Mt. Baw Baw (376/68), Forrest, Otway Ranges (447/66), Mt. Sabine, Otway Ranges (168/69). (NMV) 9·5 km NE. of Mt. Ellery, E. Gippsland (D14158-610), Mt. Nowa Nowa (D13790-812), Mt. Baw Baw (D9603), 4 km SW. of Mt. Baw Baw (D13556-65, D13582), 5 km SW. of Mt. Baw Baw (D13586), 10·5 km S. of Kel Junction, Noojee Rd. (D16869-71), 3 km S. of Pennysaddle, Noojee Rd. (D16872-74), Loch Valley Camp (D14864-68), Springvale (D5535), Bunyip, Gippsland Rd. (D2482), Narracan (D1607), Meeniyan (D937), Barwon Downs, Otway Ranges (D993), Gellibrand R., Gellibrand (D13396-7, D18020-1), Mt. Sabine, Otway Ranges (D13621-30), Victoria (D1092, D1359, D1746, D4228, D936-9), No data (D4192).

Specimens observed. The localities of specimens observed during field work, but not collected, are listed below.

N.S.W. 8 km NE. of Kybean (1), 5km E. of Guthega Power Station (1), 5 km ENE. of Thredbo (1), 3 km E. of Brown Mt. (5).
A.C.T. 10 km SSE. of Bulls Head, Brindabella Ranges (3).
Vict. Mt. Wills (1), 8 km WNW. of Cobungra (7), Dargo High Plains (5), 18 km SSW. of Eildon (2), 14·5 km NE. of Mt. Ellery (1), Mt. Nowa Nowa (4), 10·5 km S. of Kel Junction, Noojee Rd. (6), Tarra Valley, S. Gippsland (1).

Distribution

Highlands of SE. N.S.W. and E. Vict. (from the Jenolan area, Blue Mountains, to Lake Mountain) with isolates in the Gisborne area and Otway Ranges, Vict. (Fig. 2a).

Habitat

Found only in regions of high rainfall (more than 75 cm per year). Populations within these regions are restricted to dead trees or rocky outcrops in montane wet sclerophyll forests and rocky outcrops in subalpine woodlands. The exposed surfaces of the trees or rocks are used for basking and foraging sites during activity, while crevices are used for shelters when inactive.

Ecology

From field observations *P. spenceri* is known to be a highly active insectivorous skink. During activity, specimens continually move over exposed sunlit and shaded surfaces seeking insects. They pause on sunlit surfaces only for brief basking periods to elevate body temperature. This thermoregulatory behaviour pattern classifies them as shuttling heliotherms (Rawlinson in press). *P. spenceri* is the most agile reptile found in the cool and cold temperate zones of SE. Australia. It is mainly arboreal, and specimens have been observed on the trunks of tall dead trees 50-75 m above ground level. The densest populations are found on large fire killed or fire damaged trees in burnt regenerating montane forests. These populations are able to survive on tall dead trees even after the regenerating forest below has formed a dense canopy excluding the species from ground level habitats, because the projecting trees still provide basking and foraging sites and shelter.

Two large dens of hibernating lizards were located in rocky subalpine woodlands on 3 May 1966. The dens were both under large dry overhanging granite exfoliation sheets that faced in a N. direction. It was not possible to accurately count the number of specimens in each den, for most specimens fell from the rock when exposed and were lost in the dense undergrowth. However, it is estimated that there were about 20 specimens in the first den and over 50 in the second.

Laboratory measurements of the thermal tolerances of *P. spenceri* have been made from continuous recordings of body temperatures (Table 1). The "Normal Activity Range" i.e. the "Voluntary Minimum" to the "Voluntary Maximum" body temperatures (Brattstrom
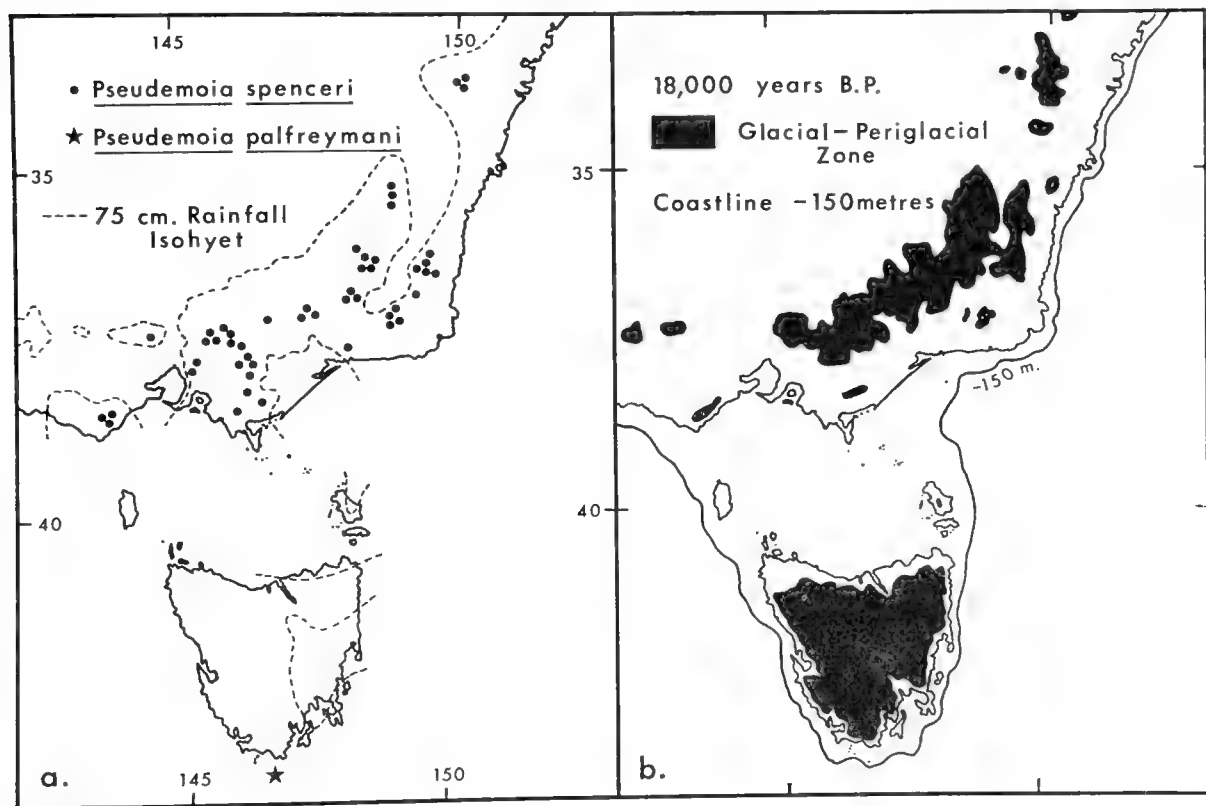

Fig. 2—(a) Distribution of *Pseudemoia spenceri* and *Pseudemoia palfreymani* sp. nov. in SE. Australia, and position of the 75 cm rainfall isohyet.
(b) Map of SE. Australia showing approximate extent of glacial and periglacial zones and coastline (−150 m contour) 18,000 years B.P. during the Late Wisconsin glacial phase.

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1965) was determined by placing instrumented animals in a photothermal gradient (15-50°C) and allowing them to thermoregulate while body temperature was recorded. Specimens in the gradient mirrored their thermoregulatory behaviour in the field i.e. shuttled continuously from under the radiant heat lamps to shaded cool areas and back. From body temperature measurements made at one minute intervals on 12 specimens (1,106 observations) it was determined that the "Mean Preferred" body temperature was 31·9°C, while the "Voluntary Minimum" and "Voluntary Maximum" body temperatures were 25·3°C and 40·3°C respectively (Table 1). The histogram of frequency of body temperatures maintained during activity (1°C class intervals, range 20-42°C) is skewed towards the high temperature end of the scale. The mode lies at 36°C, and no temperature interval has more than 9% of the observations. This result reflects the shuttling method of thermoregulation, and the consequent rapid fluctuation in body temperature as the lizard moves rapidly to and from the basking site.

Spellerberg (1972) determined the "Critical Maximum" and "Critical Minimum" body temperatures. These are the temperatures at which locomotory ability is lost as measured by the loss of the righting reflex. The "Critical Minimum" is 2°C and the "Critical Maximum" is 41·9°C. Thus *P. spenceri* has wide thermal tolerances (cf. comparative table in Brattstrom 1965). It tolerates large fluctuations in body temperature during voluntary activity, the mean normal activity range for specimens tested was 15°C (25·3°-40·3°C), the absolute range was 22°C (20°-42°C), and

TABLE 1

Thermal tolerances of **Pseudemoia spenceri**

Body Temperature Value	Number of Observations	Mean °C	Range °C
Critical Minimum Temperature	8	2·0	1·5- 2·8
Voluntary Minimum Temperature	12	25·3	20·0-31·9
Mean Preferred Temperature	1106	31·9	– –
Voluntary Maximum Temperature	12	40·3	39·1-42·0
Critical Maximum Temperature	8	41·9	41·3-42·5

specimens are capable of co-ordinated movements over a very wide range of body temtures, a mean range of 39·9°C (2°-41·9°C), and an absolute range of 41°C (1·5°-42·5°C). Other striking features of the thermal tolerances of *P. spenceri* are the voluntary maximum and critical maximum body temperatures which are higher than any other SE. Australian skinks.

Reproduction

P. spenceri is a live-bearing skink. There is no trace of eggshells around developing embryos, so it is assumed the species is fully viviparous (i.e. placental). Pregnant females kept under observation in the laboratory produced litters 4-27 Feb. Of 29 pregnant females examined, 8 had one embryo, 16 had two embryos and 5 had three embryos, the mean number of offspring being 1·9.

Lygosoma (*Liolepisma*) *weekesae* is recorded above as a synonym of *P. spenceri*. Weekes (1929, 1935) described in detail the placentation of a species which was identified by Kinghorn as *L.* (*L.*) *weekesae*. However, Weekes's specimens could not have all been *P. spenceri*, for she records pregnant females carried from 3-7 embryos (cf. *P. spenceri* 1-3). The present author considers the specimens Weekes worked on belong to an undescribed species of *Leiolopisma* which occurs with *P. spenceri* in the Jenolan area (and in all other *P. spenceri* localities). In this species females carry 1-7 embryos (mean 3), and the author has previously referred to the species as *Leiolopisma weekesae*? (Rawlinson 1967, 1969, 1971a,b). It should be stressed again that all specimens used in the description of *L.* (*L.*) *weekesae* (which immediately precedes Weekes's paper) have been located, and all are conspecific with *P. spenceri*.

Pseudemoia palfreymani, sp. nov.
Pl. 5, fig. 1, Fig. 1

Holotype. NMV D8868. Locality: Pedra Blanca (= Pedra Branca) Island, off S. coast of Tasmania. Latitude 43° 52′ S, longitude 146° 59′ E. Collector: A. E. Palfurman (= Palfreyman). Date of acquisition: 30 Aug. 1956. Date of collection: Jan. 1956. External

condition good, internal preservation poor, and sex cannot be established.

Description. Snout-vent length 8·5 cm. Tail incomplete. Supranasals present and large. Small postnasal. Rostral and frontonasal in broad contact. Prefrontals narrowly separated. Prefrontals contact supranasals and exclude frontonasals from anterior loreals. Anterior and posterior loreals large. Frontoparietals fused. Interparietal separate, small. Parietals large and contact on midline. Nuchals enlarged, but no symmetrical pairs. Temporals enlarged. Four supraoculars, second the largest. Six upper ciliaries, eight lower ciliaries. Lower eyelid moveable with a large transparent palpebral disc surrounded by small granular scales. Seven upper labials, fifth enlarged and borders orbit; seven lower labials. Ear opening obvious, three slightly enlarged anterior lobules. Eight slightly enlarged preanal scales. Subdigital lamellae undivided and smooth, 22 under the fourth toe. Palmar tubercules flat, slightly rounded near base of digits. Midbody scale rows 39. Dorsal scales slightly enlarged, dorsal and lateral scales with 3-5 very faint keels.

Preserved specimen black above with pattern of irregular grey and brown flecks. A thin light coloured dorsolateral stripe arises above the eye and passes over the temporal region, along the body, and extends onto the tail where it is broken up. Ventral surface unmarked, mid-grey. Palmar surfaces dark grey.

Paratype. C106 Tasmanian Museum, Hobart (Old number Xa42) from Arve Valley, Tasm. Coll. Jan. 1957 (Locality and year of collection presumed to be in error; see below). External condition good, internal preservation poor.

Description. As for holotype except: Snout-vent length 4·5 cm. Tail incomplete. Frontonasal contacts anterior loreals and excludes prefrontals from supranasals. One pair of enlarged symmetrical nuchals. Seven superciliaries. Eight lower labials. Eleven slightly enlarged preanal scales. Twenty-two subdigital lamellae under the fourth toe. Midbody scale rows 38. Colour as holotype except dark brown above and pattern better developed.

Paratype. C285 Tasmanian Museum, Hobart (Old number Xa44) from Pedra Blanca (= Pedra Branca) Rock, S. Tasm. Collector A. E. Palfreyman Jan. 1957 (Year of collection presumed to be in error). Condition poor as specimen has desiccated at some stage.

Description. As for holotype except: Snout-vent length 8·2 cm. Tail (complete) 9·8 cm, 120% of S-V length. Frontonasal contacts anterior loreals and excludes prefrontals from supranasals. One pair of enlarged symmetrical nuchals. Two slightly enlarged anterior lobules in ear opening. Ten slightly enlarged preanal scales. Twenty-one subdigital lamellae under the fourth toe. Midbody scale rows 40. Dorsal and lateral surfaces mid-brown, heavily marked by light grey and light brown flecks. Dorsolateral stripe absent.

Additional specimen. NMV D8869. Locality, collector and date of collection as for holotype. Decapitated so not included in the type series. Snout-vent length unknown. Tail (complete) 10·2 cm. Nine slightly enlarged preanal scales. Twenty-one subdigital lamellae under the fourth toe. Midbody scale rows 39. Colour as for holotype.

Comment

Pedra Branca Is. is the deepest-water and southernmost island on the Australian continental shelf (Rawlinson in press). Mr. A. E. Palfreyman and Mr. M. Forster made the first recorded landing on 6 April 1947 (Fowler 1947, Sharland 1947). During this visit both Fowler and Sharland record that Mr. Palfreyman saw ". . . at least 25 lizards, each about 9 inches long . . ." on the W. side. Mr Palfreyman re-visited the island in January 1956 and (pers. comm.) "collected six lizards . . . 3 lizards were sent to the Museum in Victoria and the others were given to the Hobart Museum". Only four of these specimens could be located, the two listed above from the National Museum of Victoria (D8868, D8869) and the two from the Tasmanian Museum (C106, C285). Data with the NMV specimens is accurate except the name of the collector was misspelt. Data with the Tasmanian Museum specimens is inaccurate; TM

C106 has the old number Xa42, TM C285 has the old number Xa44, and it appears likely that the third specimen donated was Xa43. Both specimens are registered as collected in 1957, and the locality given to TM C106 in the new register is "Arve Valley, Tasmania". Only two of the specimens (NMV D8868, TM C106) are in reasonable condition. In view of the extreme difficulty involved in collecting more specimens (Fowler 1947) and the importance of the record to biogeographers and ecologists, it was decided to describe the new species using the material available. The species is named in honour of Mr. A. E. Palfreyman without whose interest and efforts the species would have remained unknown.

Distribution

Known only from Pedra Branca Is. 26 km S. of mainland Tasmania (Fig. 2a). It is surrounded by water over 128 m deep. *P. palfreymani* may also occur on adjacent S. Tasmanian islands (e.g. Mewstone Rock) but it is considered most unlikely that the species will be found on the Tasmanian mainland.

Habitat

Pedra Branca Is. is an isolated wave-swept rock composed of Precambrian sandstone and barely reaching 55 m above sealevel (Fowler 1947, Ritchie 1969). The rock lacks vegetation, but is the site of large breeding colonies of Australian Gannets, *Sula serrator*, and Australian Fur Seals, *Arctocephalus doriferus* (Fowler 1947, Sharland 1947). It is assumed that *P. palfreymani* uses exposed rock surfaces for basking sites during activity, and rocky crevices for shelter when inactive.

Ecology

Unknown. *P. palfreymani* probably is a shuttling heliotherm like *P. spenceri*. In the absence of terrestrial vegetation, it appears that the lizard would live off the bird colony by scavenging in the same way as the *Leiolopisma* skinks found on similar islands in the Chatham Group, New Zealand (McCann 1955).

Reproduction

Unknown. In view of the habitat, *P. palfreymani* is most unlikely to be oviparous and the species is assumed to be completely viviparous like its near relative *P. spenceri*.

Relationships of the genus **Pseudemoia**

When figuring the palatal bone structure of *Morethia lineoocellata*, Fuhn (1969) put forward the idea that if the palatal structure of *P. spenceri* was similar, *Pseudemoia* might prove to be congeneric with *Morethia*. The skull of *P. spenceri* has been examined and the palatal bone complex is essentially the same as *M. lineoocellata*, but Fuhn's idea of a close relationship between *Pseudemoia* and *Morethia* must be rejected. In all *Morethia* species (Smyth 1972, Storr 1972) the lower eyelid consists of a transparent disc fused to the eye surface, the interparietal and frontoparietals are fused into a single scale, and midbody scale row counts never exceed 34, and range as low as 24. Also *Morethia* species are all oviparous and inhabit warm, dry habitats across S. Australia; they do not enter the cool or cold temperate areas (Rawlinson 1971).

Pseudemoia only differs from the large genus *Leiolopisma* (sensu Greer 1970) in the possession of supranasal scales and there are several easily distinguishable groups within this latter genus. One of these, the "alpha Australian South Pacific Group" of *Leiolopisma* skinks (Greer and Parker 1968) have exactly the same palatal bone structure as *P. spenceri* (and *Morethia*) and all species are truly viviparous. Within this "alpha" group are two groups, viz. species with low midbody scale counts (20-32, e.g. *L. entrecasteauxii* and *L. metallica* in Australia, *L. aeneum* and *L. zelandica* in New Zealand) and species with high midbody scale counts (38-66, e.g. *L. ocellata* and *L. pretiosa* in Tasmania and most of the New Zealand *Leiolopisma* spp.). The high scale count "alpha" *Leiolopisma* species are the closest relatives of *Pseudemoia*, and in some *L. ocellata* specimens there are partially separated supranasal or postnasal scales. Further taxonomic work will probably place these *Leiolopisma* species in the genus *Pseudemoia*.

Biogeography

Pseudemoia belongs to a group of skinks

("alpha" *Leiolopisma*) which has radiated widely into the cool temperate regions of the S. Pacific area during the Quaternary. *P. spenceri* and *P. palfreymani* are the only species in this group with supranasal scales and they are undoubtedly closely related. They represent an ancestral stock which probably reached Tasmania in the Illinoian or Early Wisconsin glacial phase when sea level fell to more than minus 80 m connecting Australia for the first time (Rawlinson in press).

The explanation of the present distribution patterns of *P. spenceri* and *P. palfreymani* lie in the climatic and sealevel changes of the Late Wisconsin glacial phase and the postglacial phase (Rawlinson, in press). The Late Wisconsin glacial phase lasted from about 40,000-10,000 yr B.P. and it was apparently the most intense of all the Quaternary glaciations in SE. Australia. At the peak of the glaciation 20,000-18,000 yr B.P., the sea lay at minus 132-150 m (Fig. 2b) and for the first time Pedra Branca Is. and adjacent rock outcrops would have been connected to mainland Tasmania, *P. palfreymani* probably then moved into the area. During the Late Wisconsin the glacial and periglacial zones would have been extensive in Tasmania (Fig. 2b). These zones lack terrestrial ecosystems so the distribution of *P. palfreymani* would have been largely coastal and probably restricted to S. Tasmanian rock outcrops. When sealevel rose isolating Pedra Branca 18,000 yr B.P., the glacial phase was still in full force, and the species did not successfully re-establish itself in Tasmania, perhaps because it was entirely dependent on seabird colonies and these were restricted.

During the Late Wisconsin, Tasmania was joined to Australia for about 9,750 yrs from 22,500-12,750 yr B.P. At this time *P. spenceri* must have had a restricted distribution on the Australian mainland for it did not reach the Bass Strait islands or Tasmania. The species has successfully invaded S. Victoria adjacent to Bass Strait in postglacial times, and it is now found in montane wet sclerophyll forests or subalpine woodlands in most high rainfall areas (Fig. 2a). Why the species should have

been restricted in a colder period is not immediately apparent, for it presently occupies the altitudinal zones which would have been below the periglacial zone, and these would have been more extensive in the glacial phase. The best interpretation is that at the height of the glacial phase when Australia was connected to Tasmania (22,500-12,750 yr B.P.) the climate was more arid and *P. spenceri* was very restricted. Only after 12,750 yr B.P. (essentially in postglacial times) did the climate become wet enough to allow the S. expansion of *P. spenceri* into areas adjacent to the old landbridge.

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Explanation of Plate 5

Fig. 1—Holotype of *Pseudemoia palfreymani* sp. nov. NMV D8868

Fig. 2—(Left) Lectotype of *Lygosoma (Emoa) spenceri* NMV D1824

Fig. 3—(Right) Holotype of *Lygosoma (Liolepisma) weekesae* AM R9745

Footnote: Since the above was written the author has been able to examine the two syntypes of *Pseudemoia spenceri* in the British Museum of Natural History, London. These specimens, BMNH 93.6.15.3-4; RR 1946.8.15.81-82 from "Victoria" were presented by A. H. Lucas and were clearly registered and labelled as syntypes; both are conspecific with the lectotype of *P. spenceri* NMV D1824.
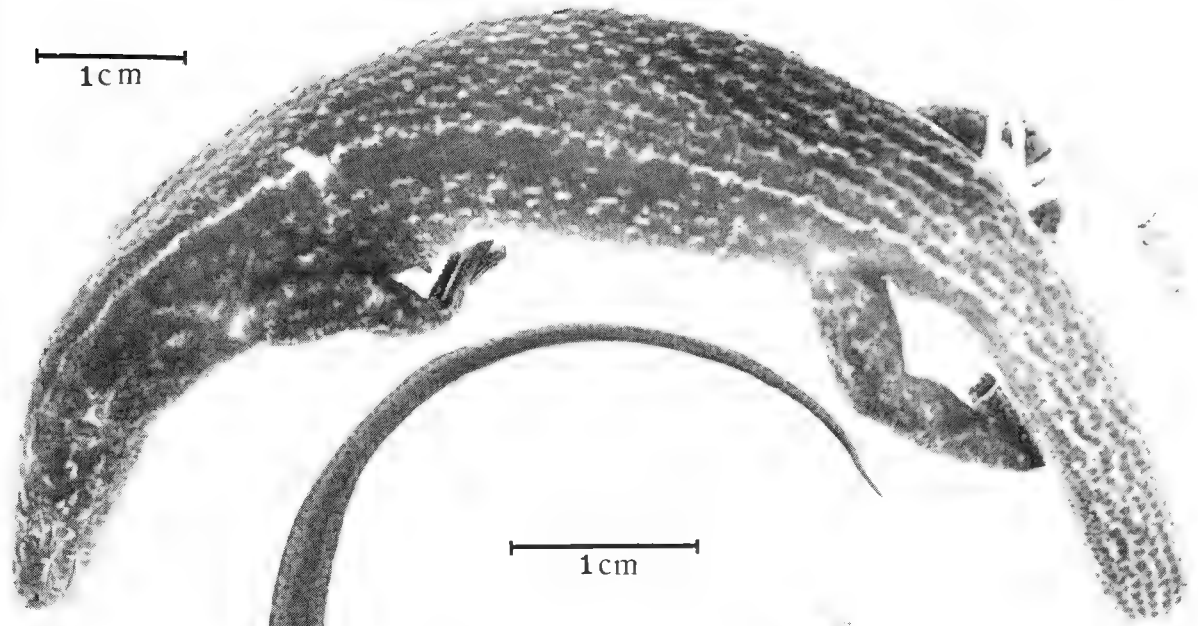
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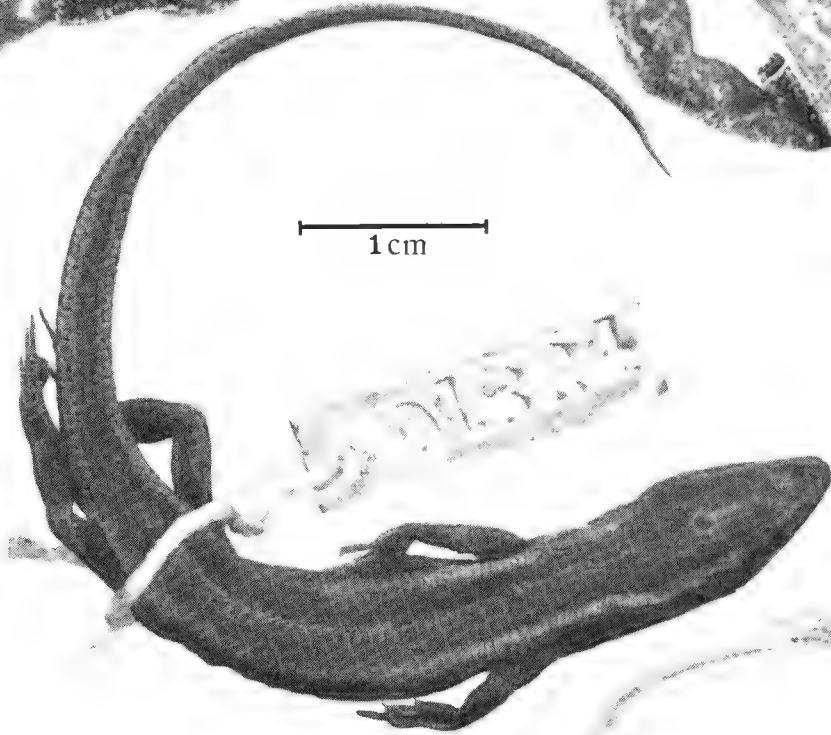
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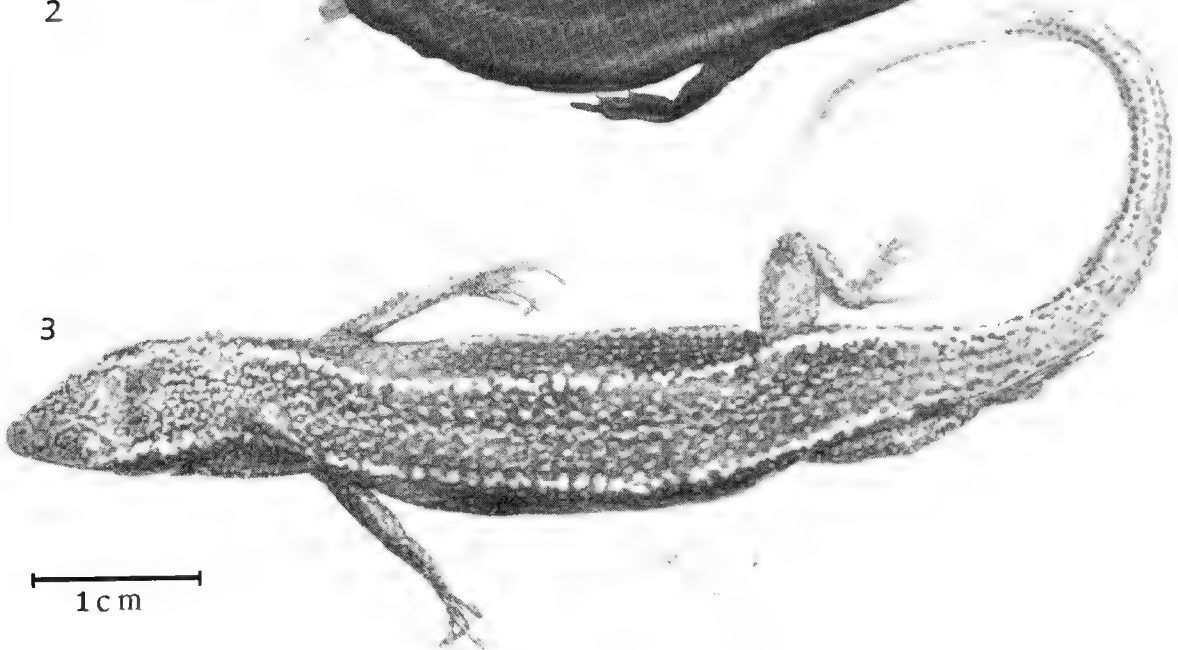
3

DOMANIBDELLA GEN. NOV., A DUOGNATHOUS 5-ANNULATE LAND LEECH GENUS IN NEW GUINEA (HIRUDINOIDEA: HAEMADIPSIDAE S.L.), WITH A DISCUSSION ON GENERAL SOMITAL ANNULATION[1]

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Abstract

Comparison with the duognathous 5-annulate land leeches of E. Australia enables separation of *Domanibdella* as having vii incomplete and viii complete 5-annulate, xxiv complete 3- or 2-annulate, genital pores xi b_5/b_6 (b_6) and xii b_5/b_6 (b_6), auricles large and the ventral margin straight not lobate, lambertian organs present and posterior. The discussion on general somital annulation supports separation in this manner at the generic level. *Geobdella tristriata* Goddard 1909 is the type species for the new genus. *Haemadipsa noxia* Blanchard 1917 is placed in *Domanibdella*.

The presence of land leeches in New Guinea has long been known, but zoological knowledge is scanty. In addition to the leeches dealt with below, Soos (1967) records for New Guinea one 4-annulate species, provisionally referred to *Philaemon grandidieri* (a species based on and known otherwise only in material from Madagascar), and two 6-annulate species, *Phytobdella maculata* and *Phytobdella lineata*, both described by Moore (1944).

This paper is concerned with the generic nature of *Geobdella tristriata* Goddard 1909, a 5-annulate land leech described very incompletely by Goddard from a single poor specimen from Fife Bay, Papua, loaned to Goddard by Mr. T. Steel.

Two 5-annulate species described by Blanchard in 1917 were reduced to synonymy under *tristriata* by Augener (1931). Augener also referred specimens he studied to this species, so that *tristriata* has become the only 5-annulate species recognized for New Guinea (Soos 1967). Augener found his specimens were duognathous, and transferred *tristriata* to *Chtonobdella* Grube 1866, a genus based on a 5-annulate land leech from near Sydney.

There is no knowledge of the survival of the type specimen studied by Goddard. Evidence is given below which associates a specimen in the collections of the National Museum of Victoria, Melbourne, with the specimen described by Goddard, and to such degree that I can only accept both as taken by the one collector in the one area. This was most probably the Rev. H. P. Schlencker of the London Missionary Society, who sent many specimens from Fife Bay to Mr T. Steel.

A description of the general somital annulation of this second specimen is given below. The data contained in the brief descriptions of the two species described by Blanchard are revised by diagrammatic analysis. This shows one of Blanchard's species has full similarity with the general somital annulation in the second specimen.

Recently collected specimens sent to me by Dr. W. Ewers of the University of Papua and New Guinea include a few 5-annulate land leeches. Some of these have the ventral and dorsal pattern as described by Goddard for *tristriata*, and all have the distinctive general somital annulation of the second specimen from Fife Bay.

These have vii incomplete 5-annulate, viii to xxii complete 5-annulate, xxiii complete or incomplete 5-annulate, xxiv complete 3- or 2-annulate.

Departure of this nature from the usual form of general somital annulation was given
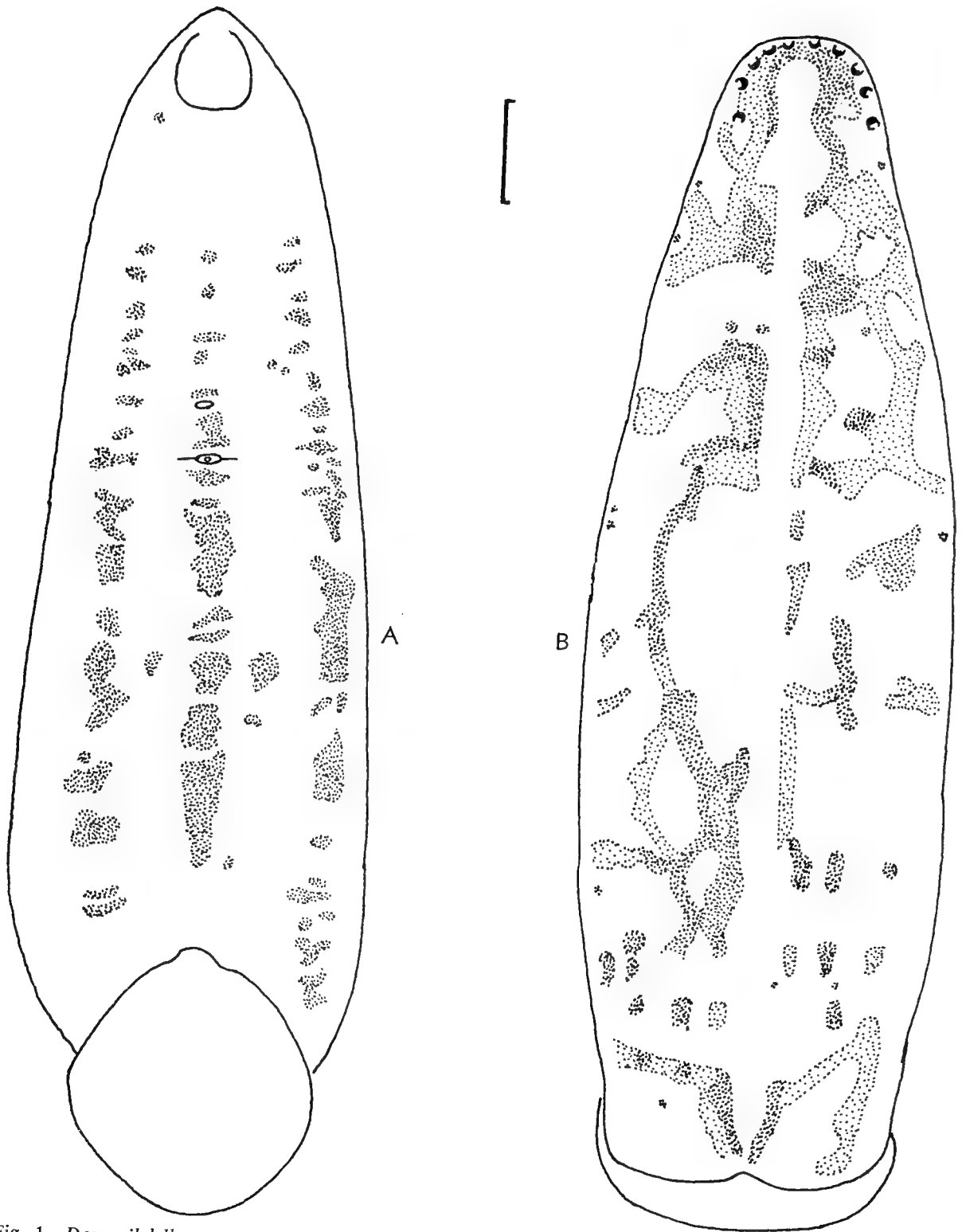
Fig. 1—*Domanibdella* gen. nov. a, ventral and b, dorsal aspects of specimen 5(a), 12 mm, Brown River, Port Moresby, showing general facies and pattern.

previously as an item in description, accepted as a simple variation, or taken as no more than specific in nature.

Following the account of the New Guinea leeches, I review the nature of genera as previously recognized for haemadipsine leeches, review the general somital annulation in hirudiniform leeches, and from the latter show that unusual levels of annulation in vii, viii, xxiv and xxv, as also others, must now be accepted as generic in status.

In the descriptions below, I give a total of the number of annuli on the dorsum between xxiii a_2 and the anus. I do this because it is often difficult to determine with full confidence the annulation of xxiii, xxiv and xxv, since there are rarely recognizable somital organs on xxiv. Annulus xxiii a_2 is recognizable by its somital sense organs, and/or by the nephropores lateral on b_2, immediately anterior to a_2.

It is only with further specimens from Fife Bay that we can be fully confident of the nature of *tristriata* as a species, but the following assembly of information demonstrates the nature of a genus in New Guinea which is distinct from the Australian *Chtonobdella* and other genera provided for 5-annulate landleeches.

1. *Geobdella tristriata* Goddard 1909.

The species is described and figured from a single strongly contracted preserved specimen, 16 mm long, collected at Fife Bay, British New Guinea. Goddard thanks Mr. T. Steel for the opportunity to study the specimen, and records 'Domani' as the native name for the leech at Fife Bay.

The description is brief and generalized, while the figure is poor; both essentially of no zoological value other than establishing the leech as of moderate size, the ocular arch haemadipsine, 5-annulate, light brown, pattern of two paramedian dark bands defining a median dorsal stripe and three longitudinal bands on the venter. The location of the genital pores was not determined.

Fife Bay is on the E. end of the S. coast of Papua, near Isuisu, on longitude 150°E.

2. *Haemadipsa noxia* and *Haemadipsa papuensis.*

These are described and named by Blanchard (1917) in his monograph on the haemadipsine leeches. They are of moderate size, the largest specimens being 24 and 25 mm long. Both are based on specimens from Moroko, inland from Port Moresby, 9°25′ S., 147°45′ E., altitude 1,300 m.

The descriptions are brief, restricted to the annulation of somites based on the somital limits of Whitman, and the location of the genital pores. The annulation given below has been converted to the somital limits of Moore by diagrammatic analysis. The species are not figured.

Haemadipsa noxia is described from seven specimens. The colour is given as greyish yellow; the pattern, some small black patches on the back. The somital annulation on the dorsum is v 2-annulate, vi 3-annulate, vii 5-annulate ($b_1 + b_2$),a_2,b_5,b_6—the 1st annulus described as "étant parfois dédoublé à la face dorsale" can be taken as a_3 below and vii 4-annulate below, viii to xxii complete 5-annulate, xxiii incomplete 5-annulate b_1,b_2,a_2,($b_5 + b_6$) above and a_3 below, xxiv 3-annulate, xxv to xxvii uniannulate, 8 annuli on the dorsum behind xxiii a_2. Genital pores xi b_6 and xii b_6.

Haemadipsa papuensis, described from 3 specimens; no reference to colour or pattern. Somital annulation v 2-annulate above, vi 3-annulate, vii 3-annulate, viii to xxii complete 5-annulate, xxiii 4-annulate, xxiv 3- or 2-annulate ($a_1 + a_2$) or a_1a_2, xxv to xxvii uniannulate, 7 annuli on the dorsum posterior to xxiii a_2. Genital pores xi b_6 and xii/xiii (xiii b_1).

Blanchard placed all 5-annulate leeches with an haemadipsine ocular arch in the g. *Haemadipsa* based on the trignathous *H. zeylanica* of S. India and Ceylon.

3. "*Chtonobdella tristriata* Goddard".

Augener (1931) identified land-leeches from Vogelkop at the far W. end of New Guinea as *tristriata*, and finding them to be duognathous, transferred *tristriata* to the g.

Chtonobdella.

The colour is given as (preserved) dorsum generally greyish yellow; the venter paler, whiter, immaculate; the pattern on the dorsum two paramedian longitudinal brown bands, each more or less interrupted and poorly represented posteriorly; a narrow dorsomedian stripe in one specimen, broken in another; dark brown supramarginal bands widening segmentally to enclose a patch of the background colour.

The annulation is based on a recurring elongate annulus, the fifth in each complete somite, and only the number of annuli between the genital pores. There is no way in which the general somital annulation can be derived from this data.

As described by Augener, the specimens cannot be recognized as any more than duognathous 5-annulate land leeches of moderate size, up to 25 mm long, with 4·5 annuli between the genital pores. The record has value in demonstrating the wide range of 5-annulate land leeches in New Guinea.

4. *National Museum of Victoria G834*

A single specimen of 5-annulate land leech, 22 mm long. There is a label reading "Fife Bay, British New Guinea. Bush leech. Native name—Domani".

The label carries the proposal of a new generic name, with 'steeli' as a proposed specific name, and the date of April 1902. No account of this specimen has been published. The proposed generic and specific names have not been used. The geographic origin, the data on the label including the name Domani, and the use of the name of Mr. Steel, can only be taken as associating this specimen with the one described by Goddard.

G834 is generally dark brownish in colour with no remains of other colour or pattern. Preserved in alcohol, it is hardened and unsuitable for the study of the auricles, jaws, etc., or for dissection.

It is moderately contracted to be heavy bodied, the dorsum transversely convex, margins obtusely rounded, venter low convex. The velum is thick, its margins continuous with the margins of the body which widens rapidly initially, the margins then parallel along the greater length of the body, narrowing slightly to the base of the posterior sucker which is 4 mm wide, wider than long, and slightly wider than the maximum width of the body.

Interannular and intersomital grooves equivalent, somital limits not directly recognizable, annuli strongly areolate and so strongly contracted that the relative lengths are not generally assessable, somital sense organs erratically detectable, nephropores on ix to xxiii obvious as small open pits on b_2.

The velum folded, concealing somites i to iii, iv uniannulate with the 1st nephropore lateral to the ocular areola, v 2-annulate above with the 4th eyes on $a_1a_2 > a_3$ and uniannulate below, vi 3-annulate above $a_1 > a_2 < a_3$ with the 5th eyes on a_2 (and possibly 3-annulate below), vi a_2 and ix a_2 separated on the dorsum by 13 annuli, vii 5-annulate above $(b_1 + b_2),a_2,b_5,b_6$ (? 4-annulate below), viii to xxii complete 5-annulate, xxiii distinctly 5-annulate on the dorsum $b_1,b_2,a_2,(b_5 + b_6)$ and can only be interpreted as 4-annulate below $b_1 + b_2 + a_2 + a_3$, 9 annuli on the dorsum between xxiii a_2 and the anus, xxiv 3-annulate a_1,a_2,a_3, and a_3 the last annulus complete across the venter, xxv 2-annulate, xxvi and xxvii uniannulate, anus at the posterior edge of xxvii, auricles elongate, lateral to xxiv a_3 to xxvii, ventral margin continuous without distinct lobes.

Dorsum of the posterior sucker strongly areolate, the venter with a large central disc (2 mm wide) which is strongly papillate, and extending from this, strongly developed muscular ridges dividing to a total of about 80 at the edge of the sucker, clamp small and including only 5 ridges.

Genital pores xi and xii b_6.

5. *Rain forest, Brown River, Port Moresby. Two collections Dr. W. Ewers.*

(a) 12/10/71. A single specimen 12 mm long. Figs. 1-2c-e.

Pattern. On the venter longitudinal bands of closely approximated large maculae, a median band and a single pair well spaced from the median, the three about equal in width; the laterals longer than the median.
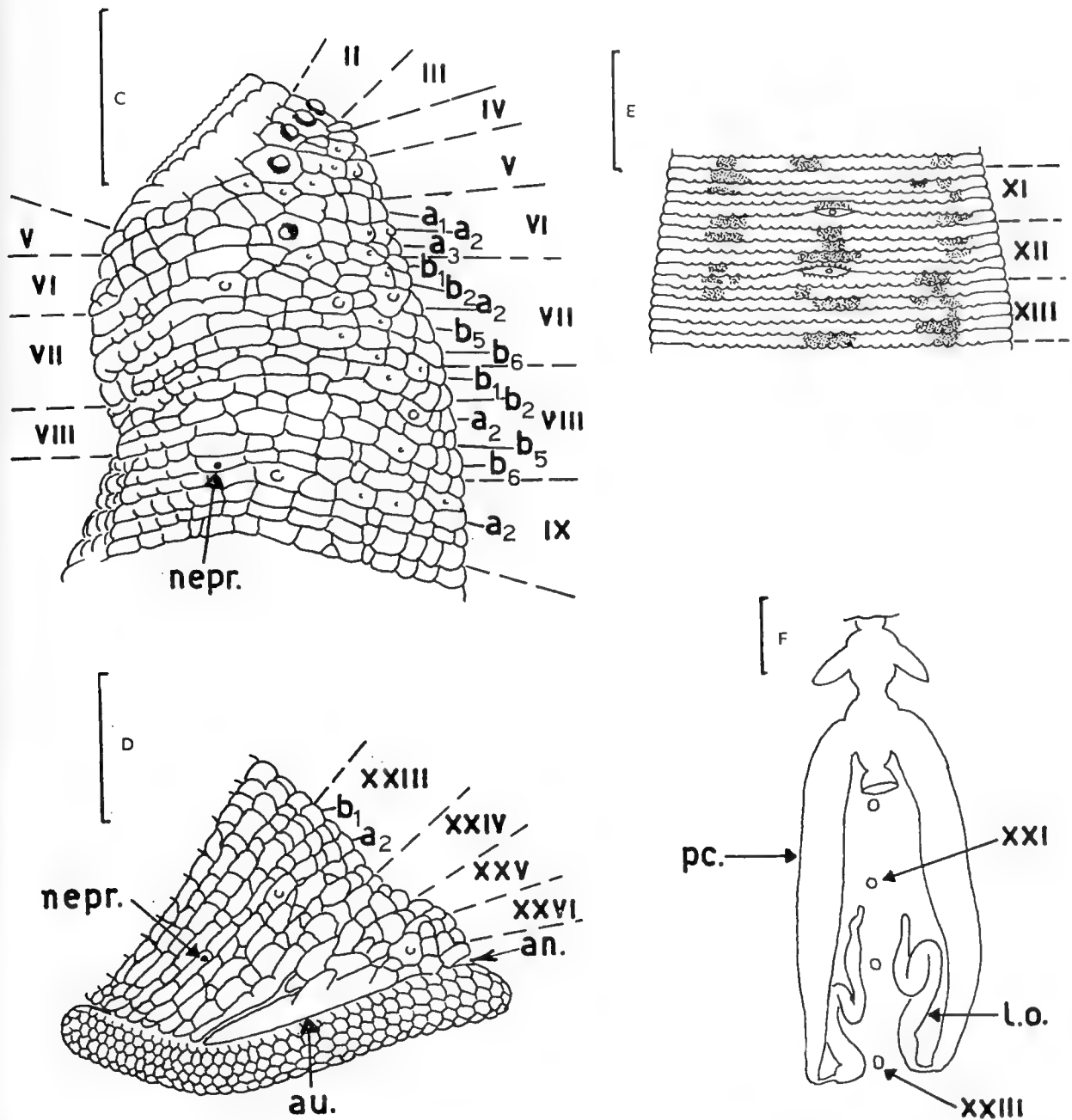
Fig. 2—*Domanibdella* gen. nov. Left lateral views of specimen 5(a), showing somital annulation; c of somites i to ix. d, of somites xxiii to xxvii, the auricle and posterior sucker. e, ventral aspect of somites xi to xiii of specimen 5(a) showing the location of the genital pores. f, the crop showing caecation on somites xviii and xix, postcaeca, and lambertian organs in 5(b)4.

Somital ganglia and somites indicated by roman numerals, somital limits by broken lines, annuli 'a₂' etc., somital ganglia represented at relative size. Scales equal 1 mm.

Abbreviations: an. = anus, au. = auricle, l.o. = lambertian organ, nepr. = nephropore, p.c. = postcaecum.

On the dorsum a median dorsal light stripe from in the ocular area posteriorly into xxv, occupying the median field and defined by a narrow dark band along each of the lines of the paramedian sense organs; these bands (possibly more complete in life) here much broken with the median stripe continuous into the adjacent fields which otherwise appear to be erratically reticulate. Towards the posterior end of the body, the pattern breaks for a few somites into transverse rows of maculae, 3 maculae on each side, suggestive of a possible pattern on the dorsum based on 6 longitudinal dark bands, converging and diverging to provide the reticulations which might extend to the line of the supramarginal sense organs on each side.

Marginal field clear, light.

Although small, there are no distinct couplets or triplets of annuli as seen in juveniles. Somite iv incomplete 2-annulate, v 2-annulate above a_1a_2 with the 4th pair of eyes $> a_3$, uniannulate below, vi 3-annulate above $a_1 = a_2$ with the 5th pair of eyes $> a_3$ 2-annulate below, vii incomplete 5-annulate above ($b_1 + b_2$), a_2,b_5,b_6 4-annulate below with a_1,a_2,b_5,b_6 the furrow b_1/b_2 reaching to the intermediate line of sense organs, viii to xxiii complete 5-annulate, xxiv briefly 3-annulate across the dorsum, then 2-annulate on the lateral and ventral aspects, xxv and xxvi incomplete 2-annulate, xxvii uniannulate, anus at the posterior margin of xxvii.

Auricles formed by the lateral margins of xxv to xxvii, very large, the lateral face and the ventral margin smooth with no indication of division into marginal lobes, no cavern but only a deep groove between the ventral face of the auricle and the dorsum of the sucker, no indication of a papilla concealed by the auricle.

Dorsum of the posterior sucker strongly areolate as five or six concentric rows, ventral face with a wide coarsely tuberculate central area, and about 80 muscular rays terminating on the margin.

Genital pores xi and xii b_5/b_6.

(b) 8/10/71. Four faded specimens preserved in alcohol.

Specimen 1. Length 15 mm, grossly contracted, unsuitable for general study. Dorsum a clear median longitudinal stripe, openly reticulated lateral to this, margins plain, venter a median band of maculae from in vi and vii to about xxi, and one pair of wide spaced bands of small maculae, each macula centred on a ventral intermediate sense organ from in vii back into about xxii—the bands broken irregularly over one or more somites.

Somite vii distinctly 5-annulate above ($b_1 + b_2$) a_2,b_5,b_6, the furrow b_1/b_2 lacking in the marginal fields and vii 4-annulate below, xxiii b_1,b_2,a_2 ($b_5 + b_6$) above, b_5/b_6 extends into the submarginal fields and a_3 across the venter.

Ventral surface of the posterior sucker coarsely tuberculate across the middle third, about 80 muscular rays terminating on the margin of the sucker.

Genital pores xi and xii b_5/b_6.

Duognathous, teeth minute, close.

Specimen 2. Length 15 mm, moderately extended, twisted along its length. Unsuitable for general study.

Dorsum a light stripe filling the median field from in the ocular arch to xxiv/xxv, on either side of this three longitudinal narrow broken bands which are separate, converge on each second somite, providing a poorly defined elongate reticular pattern. Margins clear, venter with three short longitudinal rows of maculae, the median from x/xi to about xviii, the laterals from in viii to xv (left) and xvi (right).

Annulation of vii, viii, xxiii obscure. Auricles and posterior sucker as in Specimen 1. Clamp minute.

Genital pores central in xi b_6 and xii b_6.

Specimen 3. Length 14 mm. Pattern greatly diminished.

Dorsal median stripe very poorly defined behind ix, inner paired bands along the lines of the paramedian sense organs broken into lengths shorter than a somite with a sense organ central in each length, a similar band parallel and lateral to and narrowly spaced from the inner band is of the same form and extent, and an outer short band is wider spaced from the middle band.

The dark bands being parallel, there is nothing of a reticular pattern on the dorsum.

The dorsal pattern is possibly a late form of a simple juvenile pattern.

Margins plain, light. Venter with no indication of a median row of maculae, lateral rows of maculae from in ix back into xxiii.

Ventral face of posterior sucker as in Specimen 1.

Somite vii ($b_1 + b_2$), a_2, b_5, b_6 above, b_1/b_2 ends in the marginal field and a_1 across the venter, xxiii incomplete 5-annulate.

Genital pores central in xi and xii b_6.

Specimen 4. Length 22 mm, dissected. Fig. 2f.

Yellowish across the dorsum, margins and venter white.

The median light stripe on the dorsum begins in the ocular area, expands to the left in vi and vii, terminates in x, broken to xiii, and then continues from in xiii to enter xxiv; dark bands poorly defined, erratically much broken; a reticular pattern indicated, but very incomplete; margins light, venter with a median and a pair of strongly marked maculate rows, the median from about x to xx, the laterals from viii/ix to xxiv.

Somite vii ($b_1 + b_2$), a_2, b_5, b_6 above, the furrow b_1/b_2 extends into the margins, a_1 across the venter, viii to xxii complete 5-annulate, xxiii incomplete 5-annulate, b_1, b_2, a_2, ($b_5 + b_6$) above a_3 below, xxiv 2-annulate a_3 complete across the venter as a thin ridge, 9 annuli on the dorsum posterior to xxiii a_2.

Ventral face of the posterior sucker as in Specimen 1.

Genital pores xi b_5/b_6 and central in xii b_6.

Duognathous, teeth minute, entrance to the pharynx at vi/vii or just in vii, pharynx short and very thin walled, terminating at viii/ix, crop compartments each with one pair of caeca originating from the middle third of the compartment, as also the postcaeca on xix. Postcaeca terminating in xxiii in the paramedian chambers, each continuing as a short narrow lambertan duct, the length a little more than the width of the lambertian organ which it joins. Lambertian organ elongate, cylindrical, ventral to the postcaecum, extending anteriorly, folded in the middle of its length in an s-shape, relatively much longer than seen in other land-leeches.

Reproductive systems poorly preserved, typically haemadipsine (v. Richardson 1969b), testes simple saccular with the most anterior at xiii/xiv, vas deferens extending along the paramedian chamber, entering the median chamber at xi/xii, the anterior region of the paired male duct formed on a posteriorly directed primary loop in the median chamber, epididymis on the recurrent limb. A wider sperm duct on the procurrent limb terminating in a small muscular ejaculatory bulb lateral to ganglion xi, short ejaculatory duct connecting directly to the male atrium in the posterior half of xi, the atrium ventral to the nerve cord and concealed by prostate glands, the loops on the anterior region of the male paired ducts in tandem, the left anterior to the right.

Saccular ovaries, obtusely ovate, situated in the posterior half of xii. Oviducts very short, joining without forming an obvious atrium. The female median region formed on a posteriorly directed primary loop, reflecting at the level of ganglion xiii, the posterior face of the elbow of the loop expanded into a thin-walled glandular sac terminating at ganglion xv; the recurrent, initial limb of the loop, thick-walled, about 0·5 the diameter of the strongly muscular thick-walled procurrent limb which terminates at the genital pore.

I could not detect longitudinal internal muscles terminating in the base of the posterior sucker; the paramedian palisades were not obviously thickened in the posterior somites of the body.

Summary. Section 1 shows *tristriata* as a small 5-annulate land leech with three longitudinal dark bands on the venter with broken paramedian bands on the dorsum.

Section 4 provides a somital annulation in which vii is incomplete 5-annulate, viii to xxii complete 5-annulate, xxiii incomplete 5-annulate with 9 annuli on the dorsum posterior to xxiii a_2, the genital pores at xi and xii b_6.

Section 5 contains some specimens with the ventral pattern of 1, and also a poorly formed reticular pattern based on longitudinal bands on the dorsum, vii incomplete 5-annulate, viii to xxii complete 5-annulate, xxiii incomplete 5-annulate with 9 annuli posterior to xxiii a_2

or (a_1) complete 5-annulate with 10 annuli posterior to xxiii a_2, the genital pores, xi and xii b_5/b_6 in two, xi b_6 and xii b_6 in two, and xi b_5/b_6 and xii b_6 in one.

My collection of duognathous 5-annulate land leeches from eastern Australia includes specimens from Cairns, N. Queensland to S. of Sydney, N.S.W.

None of this material has the somital annulation shown in Sections 4–5. In all these specimens, as also in the type specimens of *Chtonobdella limbata* which I have now examined, vii is complete 3-annulate, viii complete 4-annulate, ix to xxiii 5-annulate; 7 (rarely 6) annuli on the dorsum posterior to xxiii a_2, genital pores xi b_5/b_6 (b_5) and xiii b_1/b_2 ($b_2,b_2/a_2$).

The only other duognathous 5-annulate genus is *Idiobdella* Harding 1913 of the Seychelles: vii 3-annulate, viii 4-annulate, ix to xxiii 5-annulate, 7 annuli posterior to xxiii a_2, genital pores xi b_1/b_2 and xiii a_2. The genus is monotypic. In the type, the anterior region of the male paired duct is thrown into a secondary (not primary) loop during development, reflecting briefly from the middle of xiii into xiv, an epididymis (if present) short and poorly formed, a sperm duct occupying the greater part of the length of the anterior region which terminates with a narrow duct without an ejaculatory bulb (v. Harding 1913, pl. 6, fig. 6).

Although we will not know the precise specific nature of Goddard's *tristriata* until suitable specimens have been obtained from the type locality, it is now fully clear in the above that *tristriata* as also *noxia*, and the leeches in Section 5 from the Brown River, are congeneric and members of a genus distinct from *Chtonobdella* and *Idiobdella*.

The small amount of variation seen in the annulation of the posterior somites of the body is of the same order as was found in the 4-annulate *Neoterrabdella australis* Richardson 1969, a leech in which these somites also exhibit a higher level of annulation than in other 4-annulates.

It is proper now to provide a new genus based on the above assembly, to select *tristriata* as the type species of the new genus, and to indicate the specimen 5a—12/10/71 as the specimen before me in the proposal of this genus.

Domanibdella gen. nov.

Derivation: Domani, native name for a landleech in the Fife Bay area, Papua, + bdella = a leech, f.

Duognathous, teeth minute and numerous, somites viii to xxii complete 5-annulate, vii incomplete 5-annulate, xxiii complete (or incomplete) 5-annulate, 10 (9) annuli on the dorsum following xxiii a_2, xxiv complete 3- or 2-annulate, genital pores xi b_5/b_6 (b_6) and xii b_5/b_6 (b_6), auricles large and restricted to the lateral ends of xxv, xxvi and xxvii, the ventral margin straight not lobate, pharynx thin-walled terminating at viii/ix, crop compartments each with a pair of primary caeca median in the length of the compartment, postcaeca terminating as a short lambertian duct connecting to an elongate lambertian organ beneath the posterior portion of the postcaecum, reproductive systems haemadipsoid: testes saccular, vasa deferentia entering the median chamber at xi/xii, anterior region of the male paired duct reflected as a posteriorly directed primary loop in the paramedian chamber, an epididymis on the recurrent limb, sperm duct on the procurrent limb which terminates in a small muscular ejaculatory bulb, ejaculatory ducts very short, male median region micromorphic, a thin-walled amyomeric atrium entirely ventral to the nerve cord; female reproductive system mesomorphic and myomeric, saccular ovaries posterior in xii, oviducts very short joining without a defined atrium, median region formed on a posteriorly directed primary loop, recurrent limb, thick walled, narrower than the strongly muscular procurrent limb; glandular sac formed as a posteriorly directed expansion of the posterior face of the elbow of the primary loop.

Pattern: Longitudinal dark bands, simple to reticulate on the dorsum; simple longitudinal bands (maculate) on the venter.

Terrestrial, sanguivorous. Australian Region, Papuan.

Type species: *Geobdella tristriata* Goddard 1909.

The Brown River leeches and Blanchard's *Haemadipsa noxia* have the general somital annulation of *Domanibdella*.

The Brown River leeches have the ventral pattern described for *tristriata* by Goddard, b_3 differing in lacking the median band. I can see no reason at this time to separate the Brown River leeches from *tristriata*.

Blanchard's *noxia* has 8 annuli posterior to xxiii a_2, the genital pores in xi b_6 and xii b_6, and differ in having a pattern of black patches on the dorsum. The pattern can only be taken at this time as separating *noxia* from *tristriata*.

Blanchard's *papuensis* differs in having vii 3-annulate, xxiii 4-annulate, 7 annuli behind xxiii a_2, xxiv incomplete 3-annulate, genital pores xi b_5/b_6 and xii/xiii (xiii b_1). If valid, these differences set *papuensis* apart from *noxia* and *tristriata*, and leave some small doubt that *papuensis* can be admitted to *Domanibdella* other than provisionally. Certainly it cannot remain in *Haemadipsa* or *Chtonobdella*.

Dispersal of study material

5.   Rain forest, Brown River, Port Moresby. Coll. Dr. W. Ewers, University of Papua and New Guinea.

5(a).   12/10/71. Single specimen 12 mm, National Museum of Victoria G2276.

5(b)4. 8/10/71. Single specimen 22 mm, dissected. National Museum of Victoria G2277.

5(b)1,3. 8/10/71. Two specimens 15 and 14 mm, Papua and New Guinea Public Museum and Art Gallery, Port Moresby.

5(b)2. 8/10/71. Single specimen 15 mm, Australian Museum, S y d n e y W4302.

Systematic values in general somital annulation

This discussion is concerned with the nature of the general somital annulation in those leeches which can be referred to now as 'hirudiniform', i.e. having the eyes arranged in an ocular arch, typically five pairs, the lateral and ventral margins of the anterior sucker formed by somite v, the pharynx euthyl-aematous with a dorsomedian and a pair of ventrolateral primary internal muscular ridges, in most each ridge subdivided lengthwise.

This is a diverse group including terrestrial, terricolous, amphibious, aquatic, sanguivorous and macrophagous leeches. The group exhibits a range in the annulation of complete fully annulate somites from 3-annulate to 9-annulate and more.

The first descriptions of leeches included the total number of annuli. In 1886 Whitman showed the body to be divided into 'somites'; the division of the 'somites' into a middle series in which all 'somites' have the annuli always complete on all aspects, and the same number of annuli in all; and an anterior and a posterior series in which there is progressive reduction in the number and completeness of the annuli from the 'somite' contiguous with the middle series, to the end of the body. Whitman made the number of 'somites' in the middle series a primary generic characteristic, but it must be recognized that Whitman combined this feature with others (number of annuli between the genital pores, jaws, dentition, nature of the pharynx, etc.) in his definition of genera. In terms of the true morphological limits of the somites as established by Moore, Whitman's series are: anterior i to viii, middle ix to xxiii, posterior xxiv to xxvii.

The development of the concept of 'genus' in the hirudiniform leeches followed a common pattern which can be briefly reviewed in the haemadipsine leeches.

In 1859 Tennent recognized that a land leech from Ceylon had annuli grouped in fives, 3 jaws, 5 pairs of eyes arranged in an ocular arch, all as in *Hirudo medicinalis*, but differed in having the 3rd and 4th pairs of eyes on contiguous annuli. On this difference, Tennent established the g. *Haemadipsa*. This arrangement of eyes became recognized as the 'haemadipsine ocular arch', and all leeches with this arch were subsequently accepted as 'haemadipsine'. *Haemadipsa zeylanica* was shown to have 5 annuli between the genital pores, as in *medicinalis*, but a lower total number of annuli.

Further genera were defined on:

(a) the number of annuli between the genital

pores—*Chtonobdella* Grube 1866 (Australian, near Sydney, 5-annulate, 7·5 annuli between the genital pores), (also *Geobdella* Whitman 1886, specimens sent Whitman by Haswell, *Geobdella* abandoned as preoccupied).

(b) the number of annuli in a somite in the middle series of somites—*Mesobdella* Blanchard 1893 (Neotropical, 3-annulate), *Phytobdella* Blanchard 1894 (Oriental, 6-annulate), *Planobdella* Blanchard 1894 (Oriental, 7-annulate), *Philaemon* Blanchard 1897 (Australian/Oriental, 4-annulate).

Blanchard, Moore and others, followed Whitman in placing generic values on the number of somites in the middle series in aquatic hirudiniform leeches where this ranges from 14 to 17, but Blanchard (1917) in his monograph of leeches assembled as having the haemadipsine ocular arch, adhered to a separation of genera as in (b) above.

In this way Blanchard assembled 2-jawed and 3-jawed 5-annulate land-leeches in the g. *Haemadipsa*, separating species in this (as in other genera) on the number of annuli between the genital pores, the somital location of these and other external landmarks, and differences in the annulation of somites such as viii and xxiii. Colour and pattern were regarded as most highly variable, included briefly as items in specific descriptions, and given no particular value.

Blanchard did not make use of the important earlier discoveries by Miss A. M. Lambert in her excellent studies on Australian land leeches. In two papers (1898, 1899) Miss Lambert showed *Philaemon* and '*Geobdella*' were similar in being duognathous (lacking a dorsomedian jaw), and having the postcaeca each ending in a duct leading to a saccular blind organ (now the lambertian organ).

These discoveries provided a departure from the 'genus' of Blanchard. The g. *Idiobdella* Harding 1913 was based on a 5-annulate land leech from the Seychelles, duognathous, 11·5 annuli between the genital pores, and lacking lambertian organs; the g. *Tritetrabdella* Moore 1938, a 4-annulate land-leech from Malaya, trignathous, and lacking lambertian organs; the g. *Nesophilaemon* Nybelin 1943, a 4-

annulate from Juan Fernandez Islands, duognathous and lacking lambertian organs.

Soos (1967) reviews all too briefly the major zoological problems he encountered in constructing a key to the genera of land-leeches, problems stemming essentially from the zoological inadequacy of Blanchard's genera as demonstrated by Lambert, Harding, and Moore.

Following the latter workers, I had no hesitation in establishing (1969b) *Neoterrabdella* for an Australian duognathous land leech, 4-annulate, lacking lambertian organs. This has other novelty: elongate auricles bordering not only xxv, xxvi, and xxvii as is usual, but also xxiv, and an unusually high level of annulation on the somites in the posterior series. I demonstrated a distinctive morphology for the reproductive systems common to all auriculate land leeches as so far known. On the basis of the morphology of the reproductive systems, etc., I removed *Nesophilaemon* and later (1971) *Mesobdella*, both with an 'haemadipsine ocular arch' from the Haemadipsidae and associated them with the neotropical fauna. They are now in the Mesobdellidae Ringulet 1972.

I have shown (1969a) that genera are characterized for aquatic sanguivorous and macrophagous hirudiniform leeches in the morphology of the pharynx and associated structures, combined with the distinctive morphology and morphological relationships of organs on the anterior region of the male paired duct, as also the diversity of distinctive morphological forms of the male and female median regions. This divided some earlier genera and provided additional genera, many having a common general somital annulation. This has led to the demonstration of systematic values in the topography of pattern, and shown pattern may be similar in related genera Richardson 1970, 1972b).

As I extend my experience of the auriculate 5-annulate leeches in E. Australia, I find these to be similar, monotonous in general somital annulation, essentially constant in the number of somites in the middle series, and the anterior and posterior series each reducing in the one

manner; a similar somital annulation for the genital pores, as also the auricles, etc. So far I have seen in them no significant variation in the nature of the pharynx and associated structures, or in the morphology of the reproductive systems. There is variety in the form of the lambertian organs, but this has not yet been adequately studied.

With Blanchard and others all would be one species in a single genus, as also a single genus in terms of the principles I have provided for genera in other hirudiniform leeches.

All have a pattern of longitudinal contrast stripes dividing the dorsum into bands. Some of the 5-annulates separate as having distinctive patterns, differences in pattern as distinctive as separate groups of genera in the aquatic sanguivores in the Richardsonianidae. Others have superficially similar patterns but separate in terms of distinctive differences in details of the topography of the patterns.

Pattern provides indications for generic separations of the E. Australian auriculate 5-annulates equivalent to the generic separations now established for the Australian aquatic jawed sanguivores. Such auriculate 'genera' cannot be substantiated in the combination of the characteristics employed with the latter, at least not so far as I have gone.

Experience with *Neoterrabdella* and also the Australian aquatic jawed sanguivorous g. *Habeobdella* directs attention to the need for an examination of the nature of the general somital annulation other than in Whitman's use of only the number of somites in the middle series as a systematic characteristic. In doing this, it is found that we can divide the hirudiniform genera into two major groups, each group diverse in content and not in itself of systematic status.

Mesobdella (Mesobdellidae, Neotropical) is the only hirudiniform genus with a 3-annulate condition in the middle series, and this series consists of vii to xxiii, with the posterior series having xxiv incomplete 3-annulate, xxv and xxvi 2-annulate (Richardson 1971).

A 4-annulate condition in the middle series in hirudiniform leeches is known only in the Haemadipsidae (Australian/Oriental) and the Mesobdellidae (Neotropical). In the majority of

these genera the middle series is viii to xxiii (in some xxiii incomplete), and the posterior series (incomplete xxiii) xxiv 2- or uniannulate, xxv to xxvii uniannulate and incomplete.

In the great majority of 5-annulate genera of hirudiniform leeches (Haemadipsidae, aquatic sanguivores and macrophages) the middle series is ix to xxiii or ix to xxiv, and rarely (*Aetheobdella*, Ornithobdellidae, Australian; *Whitmania* 1 sp., F?, Oriental; *Semiscolex* 1 sp., Semiscolecidae, Neotropical) viii to xxiv.

In terms of general somital annulation, the above forms a hirudiniform group in which with few exceptions vii is complete 3-annulate (exceptionally incomplete 4-annulate), vi incomplete 3-annulate (exceptionally complete 3-annulate), v incomplete 2-annulate (exceptionally complete 2-annulate), iv to i not formed ventrally with iv 2- or uniannulate, iii to i uniannulate.

In this group with the exception of *Mesobdella*, viii is 4-annulate in the great majority, exceptionally incomplete 5 - annulate, and rarely complete 5-annulate.

The second group includes a relatively small number of hirudiniform genera in which the annulation of the middle series is 6- 7- 8- or 9-annulate. I lack data on a 12-annulate still in the g. *Diestecostoma*.

In the 6-annulate *Phytobdella* (Haemadipsidae, Oriental/Australian) vi is 3- to 5-annulate, vii 5- or 4-annulate, viii 6- or 5-annulate, ix to xxiii 6-annulate, xxiv 2-annulate, xxv to xxvii uniannulate (v. Moore 1944).

In the 6-annulate species of *Gastrostomobdella* (Gastrostomobdellidae, Oriental) v is 2-annulate or incomplete 3-annulate, vi 2-annulate or incomplete 3-annulate, vii complete 4-annulate, viii 5- or 6-annulate, ix to xxiii 6-annulate, xxiv 4-annulate, xxv 3-annulate, xxvi 2-annulate, xxvii uniannulate (v. Moore 1929).

The 7-annulate g. *Planobdella* (Haemadipsidae, Oriental) is known only in Blanchard's descriptions (1917). From this the somital annulation appears to be: vi 5- (? complete) annulate, vii incomplete 6-annulate, viii to xxii (possibly also xxiii) 7-annulate, xxiv ?

The 8-annulate g. *Kumabdella* (Gastrostomobdellidae, Oriental) has: v 2-annulate,

vi 6-annulate above 4-annulate below, vii 5-annulate above 4-annulate below, viii to xxv 8-annulate, xxvi complete 5-annulate, xxvii incomplete 2-annulate (Richardson 1972a).

The terrestrial 8-annulate g. *Diestecostoma* (Diestecostomidae, Neotropical) can be included as most certainly hirudiniform. In this v is incomplete 2-annulate, vi 3-annulate, vii 3-annulate (incomplete 4-annulate), viii 4-annulate, ix, x, xi each 5-annulate, xii 7-annulate, xiii to xxii 8-annulate, xxiii 7-annulate, xxiv 6-annulate, xxv 3-annulate, xxvi and xxvii (?) 2-annulate (v. Moore 1946).

The 9-annulate *Diestecostoma* (Diestecostomidae) has: v 2-annulate above (?) below, vi complete 3-annulate, vii 5-annulate above and 3-annulate below, viii 5-annulate above 4-annulate below, ix 6-annulate, x 7-annulate above 6-annulate below, xi to xxiii 9-annulate, xxiv (?) 9-annulate (v. Ringuelet 1944).

It is possible that I have omitted other examples of significant general somital annulation in hirudiniform leeches. The above is sufficient to demonstrate the need to consider the status of all three series, and not solely the number of somites in the middle series, in formulating the nature of genus in hirudiniform leeches.

Some general principles can be taken from both groups. Only in the 3-annulate *Mesobdella* does vii have the same annulation as viii and the somites of the middle series, giving the impression that vii has shifted from the anterior to the middle series, but here vii has the same annulation as in 4- and 5-annulates of the first group and in the 8-annulate *Diestecostoma*. Somite vi is essentially incomplete 3-annulate in the first group, of this form in the 6-annulate *Gastrostomobdella*, the 8- and 9-annulate *Diestecostoma*; v essentially incomplete 2-annulate in the first group, and of this form in *Gastrostomobdella*, and 2-annulate in the 8-annulate *Kumabdella*.

In the posterior series, xxvii is most commonly uniannulate in both groups, xxvi essentially 2-annulate in the first group, as also in *Gastrostomobdella* and *Diestecostoma* in the second group, xxv 3- or 4-annulate in the first group (excepting most haemadipsines, uni-annulate as also xxvi) and 3-annulate in *Gastrostomobdella* and *Diestecostoma*.

Somites viii and xxiv exhibit changes in form, but only in some increasing to the level of the annulation in the middle series. There is the clear expression of conservatism in form in both the anterior and posterior series, and to a degree which is significant.

Such conservatism in *Diestecostoma* is expressed in two genera of the second group in which the anterior limit of the middle series is xiii and xi, in contrast to ix as the general anterior somite in this series.

The great majority of aquatic hirudiniform leeches have a 5-annulate condition in the middle series. Terrestrial and terricolous genera exhibit also higher and lower levels of annulation in this series.

It can be proposed from the above that the general somital annulation is the result of two differing and independent processes:

(a) Cotylization, processes controlling the formation of the anterior and posterior suckers involving stabilization in progressive morphological reduction of the somites in the anterior and posterior series of somites, and

(b) A process leading to a uniformity of complete annulation in the somites of the middle series which constitute the greater length of the body.

Interaction between these processes can be seen in the second group where, in some, a higher level of annulation is imposed on the somites in the anterior and posterior series, but even in these the somites otherwise exhibit the conservative trends seen in these series in the first group.

The result is irregular and cannot be reduced to a single simple pattern, as can be seen in the variety of annulation on the anterior and posterior series in the 6- and 8-annulate genera.

The essential stability of form in these series in the first group of genera, and the limited number of departures from this form, can be taken in combination as demonstrating that such departures are not simply random or erratic, and are to be recognized as an essential change in the processes controlling the formation of the general somital annulation.

Such departure from the common pattern of general somital annulation in the first group is to be given systematic value at the generic level, as has been demonstrated where genera have been characterized on other grounds: *Aetheobdella* viii 5-annulate, *Domanibdella* viii 5-annulate, vii incomplete 5-annulate, etc., *Neoterrabdella* xxiv 3-annulate, *Habeobdella* xxv 5-annulate, etc.

This review illustrates the traditional contradiction in practice which, early with Whitman and since then, has accepted the level of annulation of xxiv and viii as generic in value in aquatic and other hirudiniform leeches, but not in the haemadipsines in which these features have been allowed no value or only specific value at best.

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DESCRIPTION OF THE FIRST WINGED SPECIES OF *PSEUDOBARGYLIA* (EMESINAE, REDUVIIDAE, HEMIPTERA)

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Abstract

The paper contains the description of the first winged species of the emesine genus *Pseudobargylia*, which had been known only from apterous specimens. *Pseudobargylia alata*, new species, was collected in Ballarat, Victoria. The generic definition is completed so as to include characters of taxonomic importance for the winged morph of emesines: the pronotum is abbreviated, as in the apterous morph, and the forewings have a large discal cell and a small subtriangular basal cell.

The finding of a winged specimen of *Pseudobargylia*, described in this paper, is of unusual interest because the genus had only been known from apterous species. Of the 25 genera of Metapterini, the tribe to which this genus belongs, 17 were known from apterous species only, whilst macropterous forms had been found only in eight genera.

The generic description of *Pseudobargylia* as given by Wygodzinsky (1966) can now be completed as follows:

Winged morph much as in apterous morph. Pronotum as in apterous form, covering only anterior portion of mesonotum, the latter much longer than wide. Forewings narrow, with large discal cell and small subtriangular basal cell, the latter about as long as distance between base of discal cell and insertion of Pcu on cell, as measured along Cu.

Pseudobargylia alata, new species
Figure 1

Diagnosis. A species closely resembling *Pseudobargylia iuncea* (Erichson) and *P. brunneri* (Wygodzinsky), differing from both by the presence of wings at least in the male, and by details of the outlines of the eighth sternite and the pygophore, as seen in lateral view.

Description. Male. Length of body 18·1 mm, head 1·5, thorax 5·3 and abdomen 11·3 mm.

Color of head testaceous, with wide lateral band darker; under surface of head stramineous, with 1 + 1 short longitudinal dark stripes below eyes. Thorax testaceous; pronotum darker except on dorsum; mesonotum stramineous, with narrow reddish brown stripe along middle. Abdomen stramineous above, with one central and 1 + 1 lateral longitudinal lines, reddish; castaneous below, speckled with stramineous. Connexival margin very dark, connexival sutures with small yellow spot. Pygophore dark brown, irregularly spotted with yellowish, especially on posterior half. Rostrum and antennae testaceous, first segment of antennae with wide subpiceous annulus before apex, extreme apex whitish. Fore legs testaceous; coxae extensively darkened, especially towards distal area; femur extensively dotted with dark brown, especially so on under surface; tibiae with one incomplete basal, one distinct small submedian and one wide apical annulus, dark; tarsus darkened on apical segment. Mid and hind legs stramineous; femur extensively dotted with darker, apical portion with three faint stramineous and three darker annuli. Tibia stramineous; mid tibia with one distinct and one faint similar annuli. Fore wings unpigmented, veins light brown.

Head and rostrum as shown in Fig. 1A-B; postocular region with sides distinctly coverging behind, in dorsal view. First article of rostrum falling short of level of anterior border of eye. Length of first segment of antennae 7·0 mm; relative length of segments 1/0·8/0·045/0·35.

Prothorax as shown in Fig. 1A-B, not quite three times as long as maximum height in lateral view; posterior lobe about one fourth of total length of pronotum, conspicuously
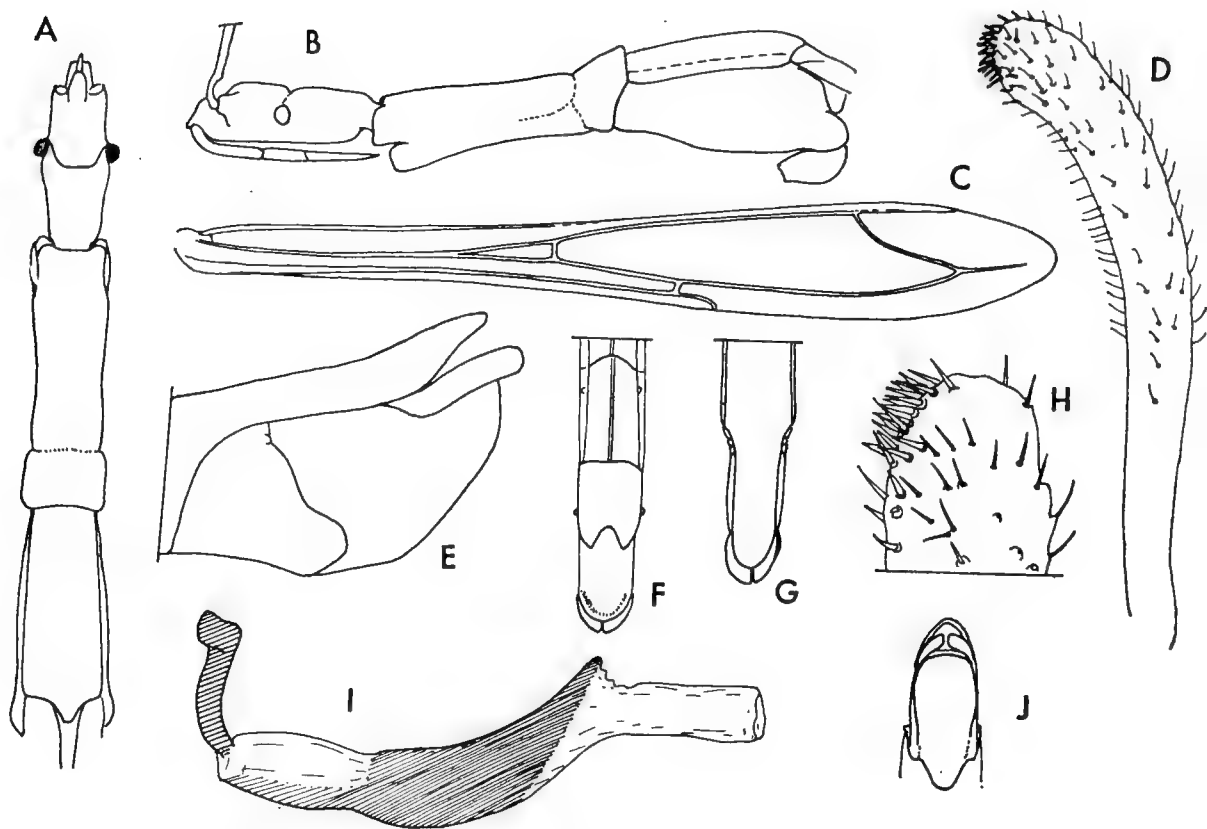
Fig. 1—*Pseudobargylia alata*, new species, male. A. Head and thorax, dorsal view. B. Head and thorax, lateral aspect. C. Forewing. D. Paramere. E. Genital region, side view. F. Apex of abdomen, seen from below. G. Apex of abdomen, seen from above. H. Apex of paramere, high magnification. I. Aedeagus, side view. J. Genital region, posteroventral aspect. Drawings by author.

wrinkled transversally. Mesonotum (Fig. 1A-B) with exposed portion as long as three fourths of length of pronotum.

Coxae of forelegs one and one half times as long as pronotum. Femora approximately 19 times as long as wide. Distance of basal process of posteroventral series from base of segment equal to about four times the length of process. Posteroventral series composed of one long basal, four or five medium-sized and about 35 small processes. Anteroventral series interrupted at base, composed of about four medium-sized and 28 small processes; process situated basad of basal interruption inserted basad of level of large basal process of posteroventral series. Fore tibiae very slightly shorter than half the length of femur; fore tarsi one

third of length of tibiae. Femora of hind legs attaining apex of abdomen.

Forewings as illustrated (Fig. 1C), somewhat abbreviated, not quite attaining level of middle of abdomen.

Abdomen slender, parellel-sided, almost 16 times as long as wide. Genital region as shown in Fig. 1E-G, J. Last tergite attaining apex of pygophore, narrowly tongue-shaped, its sides subparallel, slightly upwardly directed apically. Eighth sternite strongly emarginated apically, its sides as shown in Fig. 1E. Pygophore of simple contours laterally, in posterior view with very short, truncate, lamellate upper projection. Parameres of uniform width when seen *in situ* (Fig. 1E), apically with a group of closely spaced spine-like setae (Fig. 1D, H).

Phallosoma as shown in Fig. 1; endosoma tubular, with numerous denticles (not shown in illustration).

Material examined. Australia: Victoria: Ballarat, June 20, 1966, A. Sonsee (one male, holotype, National Museum of Victoria, Melbourne, T4496).

I am much obliged to Mr. A. Neboiss for the opportunity to study this unusual specimen.

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DESCRIPTION OF *RETUSA CHRYSOMA* BURN SP. NOV. (OPISTHOBRANCHIA) AND ITS FOOD RESOURCES FROM CORNER INLET, VICTORIA

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Abstract

Retusa chrysoma Burn sp. nov. is described from Corner Inlet, Victoria, and compared with other species reported from the Victorian coastline. Gizzard contents show selective food preferences for foraminifera and juveniles of the air breathing gastropod *Salinator fragilis* (Lamarck, 1822).

Introduction

Little is known anatomically of the shell-bearing opisthobranch molluscs of Victoria. Similarly, little is known of their food resources and selective preferences. Foraminifera are believed to form wholly or part of the food of several species of retusid opisthobranchs (Bacescu and Caraion 1956, Marcus and Marcus 1969, Moore 1961, Morton 1958, Rudman 1971), but the overall part they play in the marine food-energy cycle is poorly known (Lipps and Valentine 1970).

In order to study Australian species/food resources, we have examined a new species of *Retusa* collected by one of us (K.N.B.) at Corner Inlet, Victoria. The description of *Retusa chrysoma* has been prepared by the first author (R.B.), the analysis of the food resources by the second author (K.N.B.).

The type series of *Retusa chrysoma* and a series of foraminiferans from the gizzard contents, mounted on slides, have been presented to the National Museum of Victoria, Melbourne. The first author (R.B.) expresses his gratitude to the Science and Industry Endowment Fund, C.S.I.R.O., for continued support of this and other research on Australian opisthobranch molluscs.

Systematic Description

Order CEPHALASPIDEA
Superfamily BULLACEA
Family RETUSIDAE
Retusa chrysoma Burn sp. nov.
Figures 1-3

Description. Shell (Fig. 1) small, cylindrical, rounded anteriorly, obliquely truncate posteriorly. Colour pale yellow, thin periostracum golden yellow. Sculpture, faint growth lines at anterior end develop into raised riblets on posterior third, riblets passing obliquely over shoulder into vertex; encircled by fine, variably spaced, wavy lines, less noticeable posteriorly where the riblets are strongest. Aperture anteriorly pyriform, medially narrow and slightly constricted, posteriorly rising above the last whorl and inclined towards the axis. Columella thickened, with a nearly vertical plait rising at mid-length, with a broad reflexion behind the plait. Spire deeply sunk, shoulder of the preceding whorl visible, sculptured by oblique riblets descending to a large, smooth, papillary protoconch. Dimensions (length x breadth): Holotype 3·06 x 1·425 mm, largest paratype 3·0 x 1·5 mm, smallest paratype 1·425 x 0·78 mm, figured specimen (dry shell) 2·7 x 1·3 mm.

Animal cream; head quadrate, broader than long, with a pair of broad, thin lobes posteriorly; yellowish Hancock's organs in furrow between head and foot and close to mouth, strongly developed, thickened, harder than the surrounding skin, each with 3 or 4 shallow transverse folds; foot short, rounded anteriorly, truncate posteriorly. Gastral plates (Fig. 2) with many dark tubercles of various sizes, tubercles largest and highest posteriorly; largest plate convex on inner face, smaller plates concave. Male copulatory organ (Fig. 3) on right side of oesophagus; atrium long, dilated entally with folded walls, ciliated seminal groove to opening of elongate seminal

1

2

200 μm

prostate gland

seminal vesicle

penial sheath

3

atrium

seminal groove
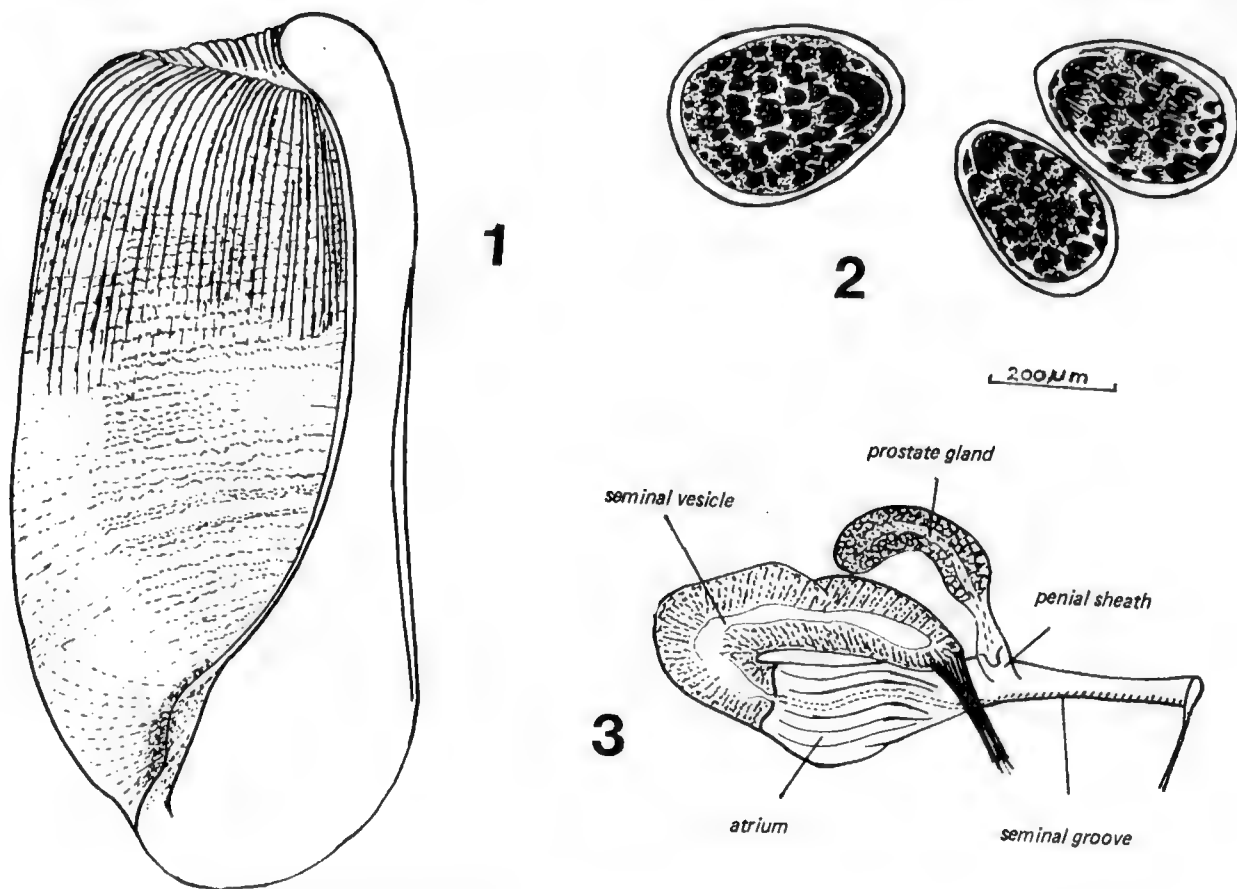
Figs. 1–3—*Retusa chrysoma* Burn sp. nov.
1, Shell. 2, Gastral plates. 3, Male copulatory organ. (Figs. 2-3 drawn to same scale).

vesicle, retractor muscle attached to end of vesicle; prostrate gland shorter than vesicle, filled with shining cells, narrower near atrium and with short papilla in penial sheath.

Material examined. From *Zostera* and mud flats on N. side of Rocky Point reef, at E. end of Bluff Road, Yanakie, Corner Inlet, Vict., collected by K. N. Bell, 11 April 1971, seven specimens (NMV F27490); 1 April 1972, eight specimens (Holotype NMV F27488 and seven paratypes NMV F27489). The specimens were obtained by sieving the top 1 cm of the substrate at mid-tide level. Other opisthobranchs inhabiting the same biotope were *Tornatina* cf. *apicina* (Gould, 1859) and *Cylichnatys* sp. nov. (Scaphandridae), and *Liloa brevis* (Quoy and Gaimard, 1833) (Atyidae).

Etymology. Chrysoma Gk. = a gold object,

vessel, plate, dress; in reference to the colour of the shell.

Discussion. The authors wholeheartedly agree with Valentine's comment (1965, p. 42) that "The forms of *Cylichnina* (i.e. *Retusa*) living in SE. Australia merit review." Examination of large series of dry shells from different localities lead us to believe that little can be achieved by this method, yet, hitherto, all Australian records of retusids and other shelled opisthobranchs have been based upon dead shells. The small amount of material collected alive that we have so far examined suggests that the animal has much importance for separating one species from the next, and that there are many local species.

In dealing with retusids of SE. Australia, we follow Rudman (1971, p. 192) in allocating those species with tubercles on the gastral

plates to *Retusa* Brown, 1827, and those with smooth gastral plates to *Relichna* Rudman, 1971. The type species of *Cylichnina* Monterosato, 1884, *umbilicata* (Montagu, 1804), has tuberculate gastral plates (Pilsbry, 1893, p. 204, pl. 60, fig. 8) and is no longer held separate from *Retusa* (Lemche, 1948, p. 50). *Cylichnina* must therefore be expunged from Australian faunal lists and replaced by *Retusa*.

There are only four species of *Retusa* reported from the Victorian coastline (Macpherson and Gabriel 1962, p. 243). *R. amphizosta* (Watson, 1886) was recorded from Portsea by Gatliff and Gabriel (1908, p. 384). Hedley (1914, p. 753) suggested their specimens might be his *R. iredaleana* (1914, p. 752). After study of a British Museum (Natural History) photograph of one of the three syntypes of *Bulla* (*Cylichna*) *pygmaea* A. Adams, 1854, from Port Lincoln, S. Aust., we are inclined to think that *R. iredaleana* from Middle Harbour, Sydney Harbour, N.S.W., and Gatliff and Gabriel's specimens are referable to *R. pygmaea*. *Cylichnina atkinsoni* (Tenison Woods, 1875) has tuberculate gastral plates (personal observations) and must be transferred to *Retusa* The *C. pygmaea* of Macpherson and Gabriel (1962, p. 243) may refer to another, apparently new, species of *Retusa* that we have from Port Phillip Bay and Shallow Inlet, Vict. It differs from true *R. pygmaea* in the narrower shape of the shell and greater inclination of the posterior lip of the aperture. *R. sculpta* (Gatliff and Gabriel, 1913) has both spiral and axial sculpture, and may be a juvenile form.

The new species, *R. chrysoma*, is distinguished from each of the above species by the riblets of the posterior third of the shell and the fine wavy spiral lines on the remainder of the surface. From species for which the animal is known, *R. chrysoma* differs in the density of the tubercles on the gastral plates.

Gizzard Contents

Live specimens of *Retusa chrysoma* Burn were collected and preserved in 70% alcohol for later study. After carefully fracturing each shell, the gizzard was dissected out, and the contents removed.

To see if any selection for food had occurred a sample of the sediment of the biotope was collected and placed in 70% alcohol. This sample was later washed to remove any preservative, placed in rose Bengal stain (1 g/l solution) for one hour, washed and dried. Foraminifera were concentrated by flotation in carbon tetrachloride. The rose Bengal stains the protoplasm of living specimens a deep red (Walton 1952).

Results

The gizzard contents of 11 specimens of *R. chrysoma* consisted of 43 specimens of foraminifera belonging to six species (Table 1) and nine specimens of juveniles of *Salinator fragilis* (Lamarck, 1822). Also present were 17 chitinous opercula which appear to be identical with the operculum of *S. fragilis*. Table 2 shows the contents of each specimen of *R. chrysoma*. From the sediment sample 15 species of living foraminifera were recovered (Table 3).

Although the number of specimens studied is small, there is evidence for selection in their food intake. This is most clearly seen with *Quinquiloculina seminula* which constitutes only 7·5% of the foraminiferal fauna but 28% of the foraminiferal food intake. The higher percentages of the food intake of *Elphidium simplex, E. advenum depressulum* and *Ammonia aoteanus* may not be significant considering the small numbers involved. The lack of any specimens of *Q. seminula jugosa* as food shows a definite selection against this species. The lack of other foraminiferal

TABLE 1

Foraminifera in the gizzard of *R. chrysoma*

Foraminiferan	No. of Specimens	%	% in sediment sample
Ammotium salsum	18	42	62
Quinquiloculina seminula	12	28	7.5
Elphidium simplex	5	12	4
E. advenum depressulum	4	9	6
Ammonia aoteanus	3	7.5	2.5
Brizalina cacozela	1	2.5	7.5

TABLE 2
Number of Foraminifera and Mollusca in *R. chrysoma* Specimens

Gizzard contents	a	b	c	d	e	f	g	h	j	k	l	Total
A. salsum	1	4		1	1	6	1	2	1	1		18
Q. seminula			1	2		5	1		3			12
E. simplex					1	2	1		1			5
E. advenum depressulum	2		1								1	4
A. aoteanus			2			1						3
B. cacozela			1									1
Salinator fragilis	1	1		2			1		2	1	1	9
Opercula	2	2			2			1	6		4	17
Total	6	7	5	5	4	14	5	8	7	2	6	

species is most likely due to their normal infrequency in the sediment.

More evidence of food selection is shown by the presence of *Salinator fragilis*. Nine specimens and 17 separate opercula were found indicating that this gastropod forms a major food source of *R. chrysoma*.

None of the specimens, foraminiferan or molluscan, showed any evidence of crushing from the gastral plates. This is in agreement with the observation of Marcus and Marcus (1969, p. 7) upon the crop contents of *Retusa sosa* Marcus and Marcus. In the present case, however, the gizzard contents all showed solution effects. Several *Ammotium salsum* were very soft suggesting that the cementing material between the sand grains had been removed, although they retained their normal shape. One *S. fragilis* had had the calcareous shell almost entirely dissolved but again had retained its normal shape. No separate sand grains were found in the intestines as would be expected from the crushing of arenaceous foraminifera. This indicates that the food is obtained by dissolving of the foraminiferal tests and molluscan shells and slow ingestion of the visceral masses. Although the gastral plates may act as a sieve as suggested by Marcus and Marcus (1969, p. 7) we prefer to consider that they act in the nature of a vice, holding the food firmly in place as the digestive processes take place. In this respect *R. chrysoma* differs from *Relichna* as Rudman (1971) found evidence for crushing of foraminiferal tests by the gastral plates in *Relichna murdochi* (Suter, 1913).

Of the four species of opisthobranch present in the biotope only *R. chrysoma* had foraminifera or molluscs in the gizzard.

Foraminiferal Reference List

The foraminifera identified are arranged in alphabetical order giving original reference and several more recent references concerned with the Australian region.

Ammobaculites sp. One small specimen is referred to this genus.

Ammonia aoteanus (Finlay).
> *Strebulus aoteanus* Finlay 1940, *Trans. R. Soc. N.Z.* 69 (4): 461.
> *Ammonia aoteanus* (Finlay). Hedley, Hurdle and Burdett, 1967, *N.Z. Dep. sci. industr. Res. Bull.* 180: 47, pl. 11, fig. 4, figs. 56-60.

Ammotium salsum (Cushman and Bronnimann).
> *Ammobaculites salsus* Cushman and Bronnimann, 1948, *Cush. Lab. foram. Res. Cont.* 24 (1): 16, pl. 3, figs. 7-9.

Brizalina cacozela (Vella).
> *Bolivina cacozela* Vella 1957, *N.Z. geol. Surv. Pal. Bull.* 28: 33, pl. 8, figs. 162-163.

Spirillina vivipara Ehrenberg.
> *Spirillina vivipara* Ehrenberg 1843, *Abh. preuss. Akad. Wiss.* 1841: 442, pl. 3, fig. 41.

TABLE 3
Frequency of Live Foraminifera in sediment

Reophax sp.	1·0%
Protoschista findens	2·0%
Ammotium salsum	62·0%
Ammobaculites sp.	0·6%
Trochammina inflata	0·6%
Textularia cf. *agglutinans*	0·6%
Quinquiloculina seminula	7·5%
Q. seminula jugosa	9·0%
Spirillina vivipara	0·6%
Brizalina cacozela	7·5%
Ammonia aoteanus	2·5%
Rosalina bradyi	1·0%
Elphidium advenum	0·6%
E. advenum depressulum	6·0%
E. simplex	4·0%

Elphidium advenum (Cushman).

    Polystomella advenum Cushman 1922, *Carnegie Inst Wash. Publ* 311: 56, pl. 9, figs. 11-12.

Elphidium advenum depressulum Cushman.

    Elphidium advenum depressulum Cushman 1933, *U.S. natn. Mus. Bull.* 161 (2): 51, pl. 12, fig. 4.

Elphidium simplex Cushman.

    Elphidium simplex Cushman 1933, *U.S. natn. Mus. Bull.* 161 (2): 52, pl. 12, figs. 8-9.

Protoschista findens (Parker).

    Lituola findens Parker 1870 *in* Dawson, *Canadian natn. n.s.* 5:176.

    Protoschista findens (Parker). Loeblich and Tappan, 1953, *Smith. Misc. Coll.* 121: 25, pl. 1, figs. 16-18.

Quinquiloculina seminula (Linne).

    Serpula seminulum Linne, 1767, *Systema Naturae.*

    Quinquiloculina seminulum (Linne). Graham and Militante, 1959, *Stanford Univ. Publs geol. Sci.* 6 (2): 48, pl. 6, fig. 6.

Quinquiloculina seminula jugosa Cushman.

    Quinquiloculina seminula jugosa Cushman 1944, *Cush. Lab. foram. Res. Spec Publ* 12: 13, pl. 2, fig. 15.

Reophax sp. A small, tapering, globular chambered *Reophax*. This appears to be an undescribed species from shallow Victorian waters.

Rosalina bradyi (Cushman).

    Discorbis globularis bradyi Cushman, 1915, *U.S. natn. Mus. Bull.* 71 (5): 12, pl. 8, fig. 1.

    Rosalina bradyi (Cushman). Albani, 1968, *Cush. Fdn foram. Res. Cont.* 19 (3): 109, pl. 9, figs. 1-2, 5-6.

Textularia cf. *agglutinans* d'Orb.

    Textularia agglutinans d'Orb., 1839, *Foram. Cuba*, p. 144, pl. 1, figs. 17-18, 32.

Trochammina inflata (Montagu).

    Nautilus inflatus Montagu, 1808. Suppl. *Testacea Britannica.*

Trochammina inflata (Montagu). Parr, 1945, *Proc. R. Soc. Vict.* 56: 194, pl. 8, fig. 4.

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MULTIVARIATE ANALYSES OF GEOGRAPHICAL VARIATION IN SOME AUSTRALIAN PASSERINE BIRDS: SIMULTANEOUS EXAMINATION OF SIX CHARACTERS

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Abstract

Canonical variates analysis was used to assess the patterns of interrelationships among populations of 19 species or superspecies of passerine birds in Australia. Six variates (bill length, bill depth, bill width, tarsus length, hallux length and wing length) were measured on nearly 4,000 specimens available in Australian museums. This multivariate approach permitted checking of the validity of presently accepted subspecies, and showed many to be gratuitous.

Isolated populations generally show a marked divergence from unisolated populations, and variation along eastern Australia in most species is very slight. In the majority of cases, patterns of variation within continental Australia are too complex to be worth naming subspecifically.

In four out of six cases of species that are present on King Is., Flinders Is. and the Tasmanian mainland, the Tasmanian population is morphologically more similar to the population on King Is. than to that on Flinders Is. This is anomalous, because populations on Flinders Is. have had longer contact with populations on Tasmania, and this should have permitted gene flow between Flinders Is. and the Tasmanian mainland to be much more extensive.

Slight differences in morphology (and plumage) of populations do not necessarily mean such populations are best treated as subspecies; it is suggested that many populations, isolated in SW. Australia, the Tasmanian mainland and the Bass Strait islands (and treated as subspecies by modern taxonomists) may, in truth, be species. The difficulties of testing such an hypothesis are evident.

The main difference between the more traditional intuitive analysis of population variation and a multivariate study such as mine is the inconsistency of the former, because a difference between populations may be regarded as either of subspecific or of specific importance. With canonical analysis more characters are considered and differences are rigorously compared.

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Introduction

In this paper, a multivariate approach, through canonical analysis, to the taxonomy of some species of passerine birds in Australia is used. It differs from the traditional approach to taxonomy by objectively combining all characters at once to give maximum dispersion between samples. The standard (univariate) approach has been to examine variation within each character separately. At worst, differences and similarities have been evaluated subjectively; at best, a criterion of 75% or 90% separation (Mayr et al. 1953) has been used. Many of the subspecies described for Australian birds seem to have a tenuous basis. For example, *Sericornis humilis tregellasi* Mathews of King Is. was described because it differs from the Tasmanian mainland subspecies in being lighter above (Mathews 1914). This subspecies and many others (not necessarily described by Mathews) clearly need evaluation with more sophisticated techniques.

In addition, the multivariate method probably better indicates the main patterns of interrelationships among populations, whereas the univariate method permits more detailed study of the characters actively responsible for the differences (Delany and Healy 1964). The univariate analysis of variation in the species studied here will be published elsewhere. The six variables measured in this study were bill length, bill depth, bill width, tarso-metatarsus length, hallux length and wing length. These were measured on all available specimens in Australia (see Acknowledgements) of 19 species or superspecies of passerines.

Multivariate treatments of biological variation are becoming more popular (Gould and Johnson 1972). Among the many applications to date, such analyses have been used to determine the probable affinity of early hominid bones (Rightmire 1972), and to study the taxonomy and evolution of mammals on islands (Foster 1965, Hope 1969), wolves (Jolicoeur 1959) and Red-winged Blackbirds (Power 1970).

Statistical Method

Suppose for any species that there are MG groups (or samples) of individuals, with M_i individuals in the i th group ($i = 1, \ldots, MG$), and that on each individual six variables $x_1, x_2, \ldots, x_6$ are measured (there is no provision for missing data). The set of these six measurements on each individual could be represented by a point in 6-dimensional space. Each of these MG groups are samples of 6-variate Normal universes (Seal 1966). Such a universe may be visualized as a swarm of points in 6-dimensional space centred at a point characterized by a mean vector and dispersed about that point as an ellipsoid characterized by a variance-covariance matrix. Each of the ellipsoids overlaps to some degree.

Using canonical analysis these data may be transformed into as few canonical variates as possible without losing any essential information. The following account of the technique is based on Armitage (1971), Delany and Healy (1964), Hope (1969), Jolicoeur (1959), Seal (1966) and van de Geer (1971). Canonical variates analysis uses a linear discriminant function
$C = c_1x_1 + c_2x_2 + \ldots + c_6x_6$ (Fisher 1936), where the coefficients c_i are arbitrary. Thus it would be possible to place one point C corresponding to each individual somewhere along an axis. However, in order that the groups can be discriminated as well as possible, the c_i's are chosen such that the ratio

$$\lambda = \frac{\text{sum-of-squares between groups}}{\text{sum-of-squares within groups}}$$

is maximized. This can be done by solving the matrix equation

$$(B - W)c = 0,$$

where B and W are respectively the variance-covariance matrices of the six measurements between and within groups, and c is the required vector of coefficients (eigenvector). λ is called the eigenvalue or latent root.

The best linear function is that with c_i's corresponding to the largest λ (call it λ_1). This function is called the first canonical variate I; it gives the best discrimination possible using a single linear function (it is equivalent to the linear discriminant function of many statistical texts (Seal 1966)). The second canonical variate II is that function with c_i's corresponding to the next largest λ (λ_2). II is uncorrelated with I between and within groups. Six canonical variates exist.

If most of the variation between groups is explained by I and II, the ratios of sums-of-squares corresponding to III to VI (i.e. λ_3 to λ_6) will be relatively small, and may be neglected. The data may then be plotted as a scatter diagram with I and II as the x- and y-axes (Figs. 1-25). Any tendency for the groups to form clusters is then immediately obvious.

My original measurements were, following Seal (1966), transformed to common logarithms, and processed on a CDC 3200 computer in the Monash University Computer Centre using a program (CANON) based on one given by Hope (1969). A print-out of the program used, somewhat modified by J. Hope (in litt.), J. R. Bainbridge (pers. comm.) and myself, is found in Appendix 4·3 of Abbott (1972). The program was checked using Reeve's (1941) data as analysed by Seal (1966).

Since the canonical variates were standardized in the analysis (that is, were made independent of the units of the original measurements), the 90% confidence limit of each mean vector can be calculated as a circle of radius $(1 \cdot 64/\sqrt{N})$, where N is the sample size. These were drawn in by Abbott (1972), but I now think that with such disparate sample sizes, it is better to leave them out.

The following constitute the samples used in these analyses.

1 N. Queensland (N. of latitude 20° S.)

2 S. Queensland (between latitudes 25 and 30° S.)
3 Queensland
4 Lord Howe Is.
5 E. New South Wales (between latitudes 30 and 35° S.)
6 Inland New South Wales (W. of Great Dividing Range)
7 Nowra
8 Canberra district
9 Victoria (includes SE. New South Wales S. of latitude 35° S.)
10 Deal Is. (between Wilsons Promontory and Flinders Is., Bass Strait)
11 Flinders Is.
12 King Is.
13 Tasmanian mainland
14 SE. South Australia and SW. Victoria
15 Mallee areas of E. South Australia and NW. Victoria
16 Murray and Lachlan river valleys in SW. New South Wales
17 Fleurieu Peninsula (includes Adelaide Plains and Mount Lofty Ranges)
18 Kangaroo Is.
19 Eyre Peninsula
20 Eyre and Yorke Peninsulas
21 Central Australia
22 S. Australia
23 S. Australia E. of Gulf St Vincent and including W. Victoria
24 W. Australia
25 SW. Australia
26 Shark Bay Islands

Distribution maps of the species studied in this paper may be found in Abbott (1972, Appendix 3). These maps show the geographical position of all specimens measured in this study.

The numbers above will be used in Figs. 1-25 to designate the samples used. The numbers of specimens in each sample for each species are listed in the Appendix.

Results

In interpreting the patterns in Figs. 1-25, it should be noted that the situation where the mean vectors ('points') of two populations fall close together does not necessarily mean those populations are conspecific. The only real, but rarely feasible, test of whether a population is of a different species from another is whether the two interbreed. Thus, clustering of points or their scattering is to be interpreted as convergence and divergence in size of most of the six characters. There are few problems with using these patterns to examine the validity of described subspecies.

Malurus cyaneus and *M. splendens*

The twelve populations used fall into two basic groups (1) Tasmanian mainland and Bass Strait islands, (2) the rest (Fig. 1). Isolated populations tend to diverge from the nearest mainland population. Thus the points for Kangaroo Is. and Fleurieu Peninsula (18 and 17), Eyre Peninsula and Fleurieu Peninsula (19 and 17), SW. Australia and Eyre Peninsula (25 and 19), and Tasmanian mainland and Bass Strait islands and Victoria (13, 10, 11, 12 and 9) do not fall close to one another. There is a bigger difference between the Victorian and New South Wales (9 and 5) populations than there is between the New South Wales and Queensland (5 and 3) populations. This would support the taxonomic conclusions of Mack (1934) if it were not for the fact that the Queensland population (3) falls also near the populations from SW. New South Wales and the Fleurieu Peninsula (16 and 17). Such a situation seems impossible to name subspecifically.

The SW. Australian (25) population of *M. splendens* is the ecological equivalent of the eastern *M. cyaneus*, and may only be a well-marked isolate of the latter. That the Kangaroo Is. (18) point falls between the Tasmanian (13) point and the Australian main-
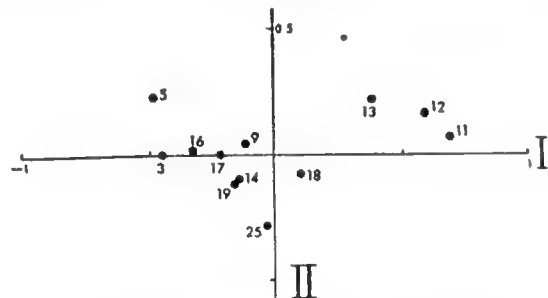

Fig. 1—Canonical analysis of variation in males of *Malurus cyaneus* and *M. splendens*.

land points is of interest, because Gould (1865) hinted that the Kangaroo Is. population might be referable to the Tasmanian form. The populations from the Bass Strait islands (11, 12) are longer-billed, longer-legged, etc., than that from Tasmania (13), but it seems scarcely worthwhile to bother naming them. The affinities of the Tasmanian population are with the King Is. (12), and not the Flinders Is. (11) population (Fig. 1).

Because the described subspecies of *Malurus cyaneus* are based on colour differences between adult males, I decided to check their validity by examining such differences with a large series of skins. Sixty-one species of adult males were sorted into groups based on the shade of blue on the back, and without looking at their geographical location. The skins were distributed geographically as follows: King Is. 4, Flinders Is. 3, Victoria 17, New South Wales 16, S. Queensland 11, Tasmanian mainland 7, Eyre Peninsula 1, Fleurieu Peninsula 2. Three groups were formed. A group containing dark blue specimens contained three of the King Is. specimens and one Flinders Is. specimen. A second group consisted of silvery-blue specimens: three from Sydney and eight from S. Queensland. The remaining group of 46 specimens showed a perfect gradation between the two extreme groups, but the gradation did not have a geographical basis. Clearly, subspecies erected on the basis of differences in colour are not satisfactory.

Sericornis frontalis superspecies and
Acanthornis magnus

The superspecies *S. frontalis* was formerly regarded (e.g. by Mathews 1930) as containing four species: *S. maculatus* from SW. Australia, Kangaroo Is. and S. Australia W. of the

E. shores of Gulf St Vincent; *S. frontalis* from S. Queensland, New South Wales, Victoria, S. Australia W. to Fleurieu Peninsula, Deal Is. and possibly Flinders Is.; *S. laevigaster* from Queensland; and *S. humilis* from the Tasmanian mainland, King Is. and Flinders Is.

The 11 male populations plotted in Fig. 2 fall into three clusters. The Tasmanian mainland, King Is. and Flinders Is. (13, 12, 11) points fall to the right; these populations consist of large individuals. Because of small numbers and unsexed material it was necessary to lump sexes of the Deal Is. (10) population. Even so, the point falls nearer to the Flinders Is. (11) point than to the Victorian (9) point. The Tasmanian population (13) falls with the King Is. (12) population.

The point representing the populations on the Shark Bay islands (26) (Dirk Hartog and Bernier islands) falls well to the left of the SW. Australian (25) point. In the intermediate cluster of points, there is little to distinguish the SW. Australia, Fleurieu Peninsula, Kangaroo Is., Queensland, New South Wales and Victorian (25, 17, 18, 3, 5, 9) points. Generally, the points for geographically close populations fall near one another. The Queensland (3) point falls nearer the Kangaroo Is. (18) point.

Because most specimens are unsexed, it was necessary to lump the sexes of *Acanthornis magnus* from Tasmania. The point (▲ 13) for

Fig. 3—Canonical analysis of variation in females of *Sericornis frontalis* superspecies ● and in *Acanthornis magnus* ▲.

this population falls with the intermediate *Sericornis* group. *Acanthornis magnus* is sometimes regarded as the senior member of a double invasion with *Sericornis* into Tasmania. It is perhaps better treated as a *Sericornis* (Keast 1968).

The female populations (Fig. 3) show a

Fig. 2—Canonical analysis of variation in males of *Sericornis frontalis* superspecies ◎ and in *Acanthornis magnus* ▲.

similar trend to the males, thus giving support to the above interpretation. That males probably predominate in the lumped populations on Deal Is. (10), and for *Acanthornis* in Tasmania (▲ 13) is evident from the positions of these points in Fig. 3.

Thus, apart from that on Kangaroo Is. (18), all the populations of *Sericornis* sens. str. from islands differ markedly from the nearest mainland populations. It also seems unnecessary to distinguish subspecifically any of the populations in the intermediate cluster in Figs. 2-3.

Acanthiza pusilla superspecies and *A. ewingi*

The genus *Acanthiza*, and especially the superspecies *A. pusilla*, have long been the despair of Australian taxonomists, such as Mack (1936) and Mayr and Serventy (1938). The reason for this is very obvious from Figs. 4-5. The populations are poorly discriminated, and even if the points were plotted in 6-dimensions the discrimination would hardly be improved (Abbott 1972, Appendix Table A5·3). Because of poorly sexed material, it was necessary to lump sexes from Central Australia.
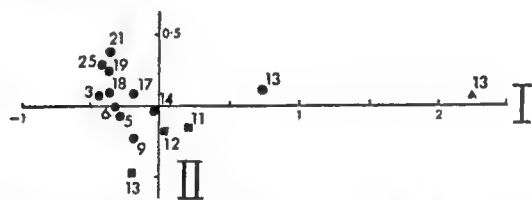
Fig. 4—Canonical analysis of variation in males of *Acanthiza pusilla* superspecies ● , *A. ewingi* ■ , and in *Acanthornis magnus* ▲ .

Geographically close populations fall near to one another in Fig. 4, and populations at both ends of the geographical range overlap least. Differences between *Acanthiza* populations are minimized in Fig. 4; *Acanthornis* was included since in some features it more closely resembles *Acanthiza* than *Sericornis* (Campbell 1900, D. Milledge pers. comm.). Morphologically, it is clear that *Acanthornis* is unlike *Acanthiza*. In Fig. 5 (females), dispersion between the *Acanthiza* samples is maximized.

In Fig. 5, the point (13) representing *A. pusilla* from Tasmania is well separated from
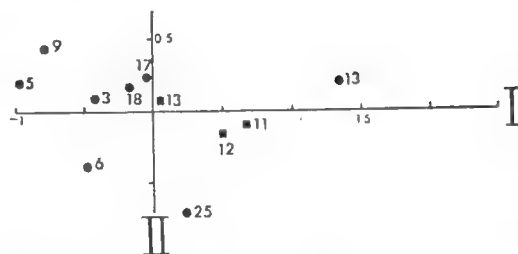
Fig. 5—Canonical analysis of variation in females of *Acanthiza pusilla* superspecies ● and *A. ewingi* ■ .

the Victorian (9) point. The points for *A. ewingi* on the Bass Strait islands (■ 11, 12) fall between those for *A. ewingi* from Tasmania (■ 13) and *A. pusilla* from Tasmania (13). The point (25) for SW. Australia falls away from that (17) of Fleurieu Peninsula.

It is probably reasonable to infer that there is very little difference between populations throughout mainland Australia, except that the SW. Australian population appears distinct from that of the Fleurieu Peninsula. According to McGill (1970), the *A. pusilla* superspecies is divided into *A. apicalis* from SW. Australia and Eyre Peninsula across to inland New South Wales, and *A. pusilla* from Queensland, New South Wales, Victoria, Fleurieu Peninsula, SE. Australia, Kangaroo Is., King Is. and the Tasmanian mainland. *Acanthiza ewingi* is found only on King Is., Flinders Is. and the Tasmanian mainland.

Acanthiza ewingi from Tasmania is morphologically more similar to *A. ewingi* on King Is. than on Flinders Is. King Is. is also like Tasmania is that it has *Acanthornis magnus* and *Acanthiza pusilla*, neither of which is known from Flinders Is.

Acanthorhynchus tenuirostris superspecies

The E. Australian populations (N.S.W., Vict., Qd. 5, 9, 3) converge morphologically,
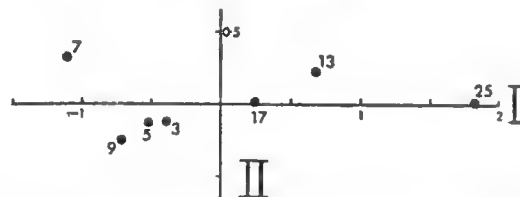
Fig. 6—Canonical analysis of variation in males of *Acanthorhynchus tenuirostris* superspecies.

showing increased size in the characters studied (Fig. 6). The SW. Australian population (*A. superciliosus*, 25) consists of small individuals, and falls nearest to the Tasmanian (13) population. The Fleurieu Peninsula (17) population is intermediate between Tasmania (13) and the E. coast group (3-9). The SW. Australian population (25) is thus quite distinct from the geographically nearest population from the Fleurieu Peninsula (17), as is Tasmania (13) from Victoria (9) and the Fleurieu Peninsula (17) from Victoria (9). This is the first case in which the isolated populations trend toward small size in most of the six characters studied (in *Sericornis* only one isolated population—that of the Shark Bay islands—tended to small size in the characters studied).

I cannot explain the separation between the New South Wales (5) and Nowra (7) points (Figs. 6-7). The trends for the female populations (Fig. 7) broadly agree with those described above for males.
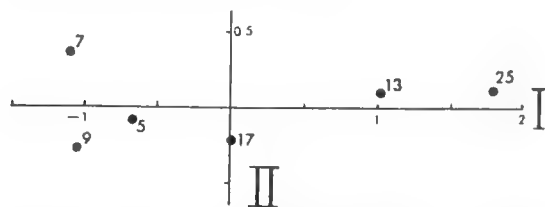
Fig. 7—Canonical analysis of variation in females of *Acanthorhynchus tenuirostris* superspecies.

The latest revision of this superspecies recognized seven subspecies (Salomonsen 1967). These are from N. Queensland, SE. Queensland, New South Wales-Victoria-SE. South Australia, Kangaroo Is., Fleurieu Peninsula, Bass Strait islands, and Tasmanian mainland. The Queensland subspecies seem unnecessary.

Melithreptus lunatus superspecies and
M. gularis superspecies

The *Melithreptus lunatus* superspecies consists of *M. lunatus* from mainland Australia and Deal Is., and *M. affinis* from the Tasmanian mainland, King Is. and Flinders Is. The *M. gularis* superspecies is made up of *M. gularis* and *M. laetior* from mainland Aus-

tralia, and *M. validirostris* from King Is., Flinders Is. and the Tasmanian mainland.

The three E. coast populations of *M. lunatus* (Qd., N.S.W., and Vict. 3, 5, 9) fall very close to one another (Figs. 8-9). Only the isolated populations show any deviations from these. The SW. Australia (25) population converges with *M. gularis* from Queensland (■ 3, Fig. 8)
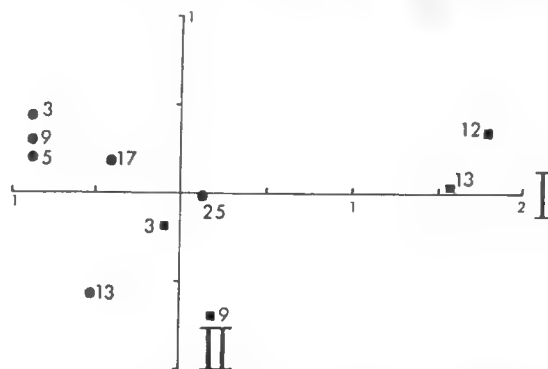
Fig. 8—Canonical analysis of variation in males of *Melithreptus lunatus* superspecies ● and *M. gularis* superspecies ■ .

by being larger. The Tasmanian (13) point falls somewhat farther from the Victorian (9) point than does the SW. Australian (25) point from that of Fleurieu Peninsula (17, Fig. 9). The Fleurieu Peninsula (17) point falls nearer to the Victorian (9) point. These findings suggest that it would be more consistent to treat both the Tasmanian and SW. Australia populations (13 and 25) either as subspecies of *M. lunatus* or as different species from *M. lunatus* (see discussion).
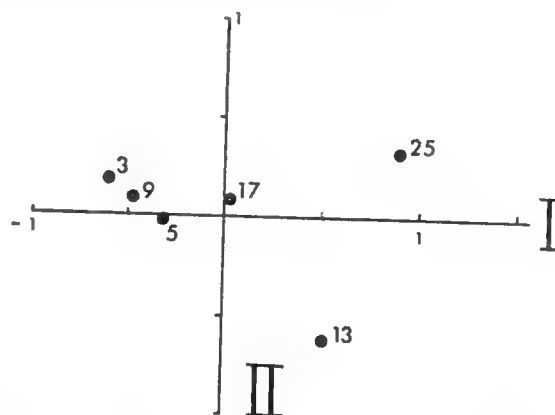
Fig. 9—Canonical analysis of variation in males of *Melithreptus lunatus* superspecies.
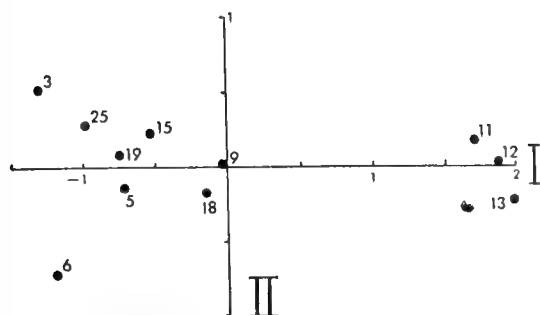
Fig. 10—Canonical analysis of variation in males of
Meliphaga leucotis superspecies.

With the *M. gularis* superspecies, the iso-
lated populations for which I have data (Tas-
manian mainland and King Is. 13 and 12) are
greatly different from the two mainland popu-
lations for which I have data (Qd. and Vict.
3 and 9) (Fig. 8).

Salomonsen (1967) recognized only two
subspecies of *M. lunatus*, one from SW. Aus-
tralia, and the other from the rest of the range.
He also recognized two races of *M. affinis*,
Tasmanian mainland and the Bass Strait
islands. I do not have enough material to check
the latter. He recognized no subspecies of *M.
gularis*, but for *M. validirostris* recognized one
for the Bass Strait islands and another for
Tasmania. This may be unnecessary (Fig. 8).

Meliphaga leucotis superspecies

The points fall into two clusters (Figs. 10-
11). The Tasmanian mainland and Bass Strait
island populations (11, 12, 13) show a nett
increased size in the characters studied. The
Tasmanian (13) point falls nearer King Is.
(12) than to Flinders Is. (11). Variation in
the mainland populations follows no obvious
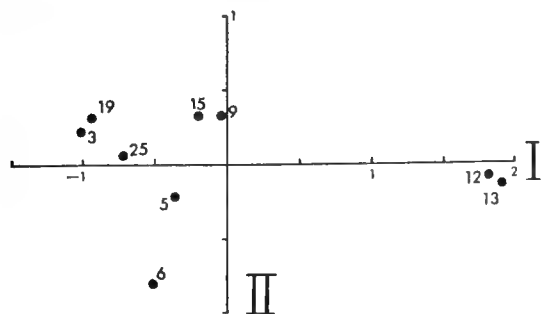
Fig. 11—Canonical analysis of variation in females
of *Meliphaga leucotis* superspecies.

trend. The populations from SW. Australia,
Eyre Peninsula and Queensland (25, 19, 3)
converge, and the inland New South Wales
(6) point falls by itself, and not with that
(15) of the Mallee areas of NW. Victoria and
E. South Australia (Figs. 10-11). It is impos-
sible to satisfactorily name this kind of vari-
ation. However, Salomonsen (1967) recog-
nized two subspecies of the mainland *M.
leucotis* (from SW. Australia, and the rest of
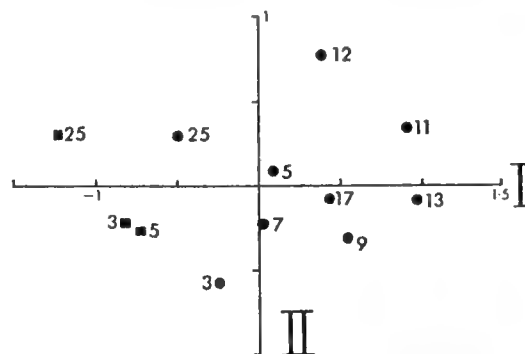
Fig. 12—Canonical analysis of variation in males of
Phylidonyris novaehollandiae ● and *P.
nigra* ■ .

the range). This is not supported by this
study. He recognized no subspecies of *M.
flavicollis*. My study supports this.

Phylidonyris novaehollandiae and *P. nigra*

There is no tendency for the points (13, 12,
11) representing the Tasmanian, King Is. and
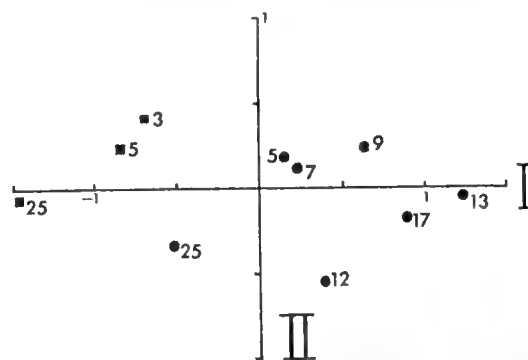
Fig. 13—Canonical analysis of variation in females
of *Phylidonyris novaehollandiae* ● and
P. nigra ■ .

that of the Flinders Is. (11) population. Little
Flinders Is. populations to cluster (Figs.12-
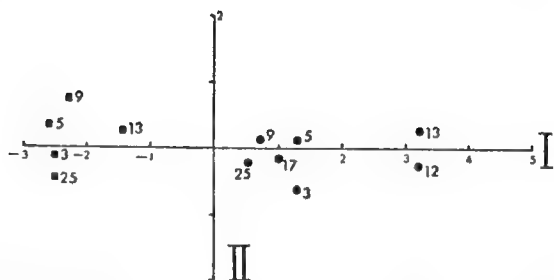13). The Tasmanian (13) point falls nearer

Fig. 14—Canonical analysis of variation in males of *Anthochaera chrysoptera* ■ and *A. carunculata* superspecies ● .

difference was found between the New South Wales, Nowra, Victorian, Tasmanian and Fleurieu Peninsula populations (5, 7, 9, 13, 17), although with the females (Fig. 13) these last two populations show slightly greater divergence from the Victorian (9) populations.

The Flinders Is., King Is. and SW. Australia populations (11, 12, 25) diverge from the geographically nearest populations (Vict., Tasm. and Fleurieu Peninsula 9, 13, 17).

P. novaehollandiae and *P. nigra* are sympatric in New South Wales and SW. Australia, but in Queensland *P. nigra* occurs alone. Surprisingly, it is the SW. Australian population of *P. nigra* that differs far more markedly from the Queensland population and not the New South Wales population.

Salomonsen (1967) recognized four subspecies of *P. novaehollandiae*: from Queensland-New South Wales-Victoria-S. Australia; Bass Strait islands; Tasmanian mainland and SW. Australia. This study supports his scheme, except that the King and Flinders Islands populations may be subspecifically distinct. With *P. nigra*, Salomonsen (1967) recognized one subspecies in Queensland-New South Wales, and another in SW. Australia. My analysis supports this.

Anthochaera chrysoptera and *A. carunculata* superspecies

The Tasmanian (13) population of *A. chrysoptera* clearly diverges from the geographically closest population (Victoria 9) for males (Fig. 14), although this is not as pronounced with females (Fig. 15). Generally, the mainland populations show little divergence from one another, with geographically close

populations being most alike. However, with males, the Queensland and SW. Australian populations (3, 25) converge in morphological variation (Fig. 14). With females, the SW. Australia (25) population diverges markedly from the nearest available population (SE. South Australia).

The populations of *A. carunculata* (from mainland Australia) all fall near one another, whereas those of *A. paradoxa* (12, 13) show marked divergence from the nearest mainland population (Victoria 9). Only Tasmania and King Is. share *A. paradoxa*.

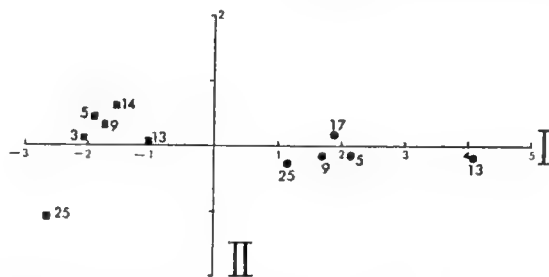Salomonsen (1967) accepted four sub-

Fig. 15—Canonical analysis of variation in females of *Anthochaera chrysoptera* ■ and *A. carunculata* superspecies ● .

species of *A. chrysoptera* (SW. Australia, Kangaroo Is., Tasmania, and rest of range), two of *A. carunculata* (SW. Australia, and elsewhere), and none of *A. paradoxa*. Possibly only the Tasmanian and SW. Australian ones for *A. chrysoptera* are worth recognizing. It is also possible that *A. paradoxa* is a well-marked subspecies of *A. carunculata* (see Discussion).

Petroica cucullata superspecies

The Tasmanian mainland (13), King Is. (12) and Flinders Is. (11) populations (*P.*
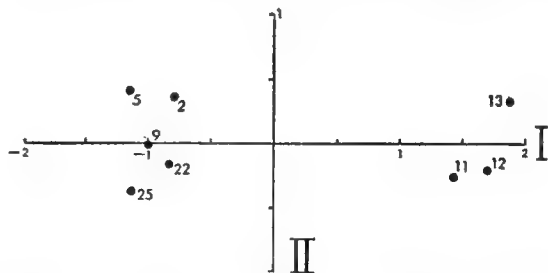

Fig. 16—Canonical analysis of variation in males of *Petroica cucullata* superspecies.

vittata) greatly diverge from the mainland populations (*P. cucullata*) (Figs. 16-17). The mainland points fall close to one another, with geographically close populations showing similar variation. Populations at the extremes of range (e.g. SW. Australia 25, and New South Wales 5) show greater dissimilarity. The Bass Strait islands and Tasmanian mainland (11, 12, 13) populations show about as much variation among themselves as do the mainland populations. The Tasmanian (13) population falls closest to the King Is. (12) population (Figs. 16-17).
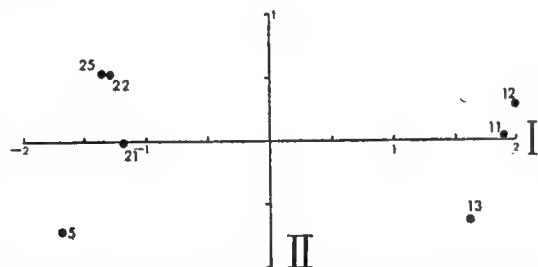
Fig. 17—Canonical analysis of variation in females of *Petroica cucullata* superspecies.

With females (Fig. 17), the same trends apply except that the difference between the New South Wales (5) and SW. Australia (25), and the Tasmania (13) and Flinders Is. (11), populations are more pronounced. Presumably such changes reflect sexual dimorphism.

Eopsaltria georgiana and *E. australis*

E. georgiana (■ 25) is endemic to SW. Australia and is regarded as the senior member of a double invasion with *E. australis* (Keast 1961). It shows marked divergence from all other populations (Figs. 18-19). *E. australis* was formerly regarded as consisting of two species (Mathews 1930). These were *E. australis* sens. str. from E. Australia, W. to SE. Australia, and *E. griseogularis* from SW. Australia and Eyre Peninsula.
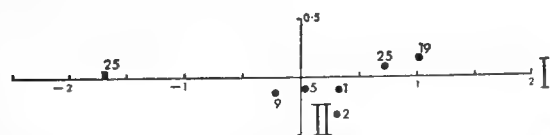
Fig. 18—Canonical analysis of variation in males of *Eopsaltria georgiana* ■ and *E. australis* ● .
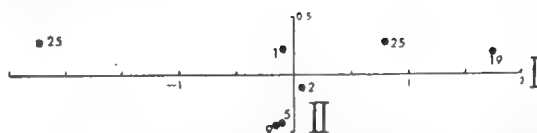
Fig. 19—Canonical analysis of variation in females of *Eopsaltria georgiana* ■ and *E. australis* ● .

The E. coast forms fall close together, with geographically close populations falling very near to one another (Fig. 18). The SW. Australia (25) and Eyre Peninsula (19) populations do show divergence from E. coast populations (1, 2, 5, 9), but it is uncertain whether they are specifically or subspecifically distinct. With females (Fig. 19), the SW. Australia (25) and Eyre Peninsula (19) populations show a much more pronounced dissimilarity from the E. coast ones. Also, the Queensland populations are more different from the New South Wales and Victorian populations.

Gymnorhina tibicen

The genus *Gymnorhina* was formerly separated into two or more species (Mathews 1930), a black-backed form from the N. parts of Australia (*G. tibicen*) and a white-backed form from southern Australia, including Tasmania (*G. hypoleuca*). Condon (1969) recognizes only one species because extensive hybrid
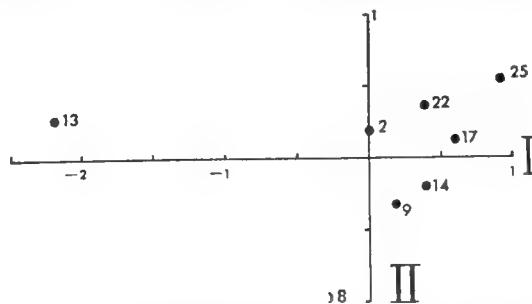

Fig. 20—Canonical analysis of variation in males of *Gymnorhina tibicen*. Point 22 refers to black-backed individuals (see map of distribution in Condon (1969)).

zones occur in S. Australia and Victoria. *Gymnorhina* is not native to the Bass Strait islands.

I found it necessary to lump sexes of the Tasmanian population because too few specimens were sexed and I could find no consistent
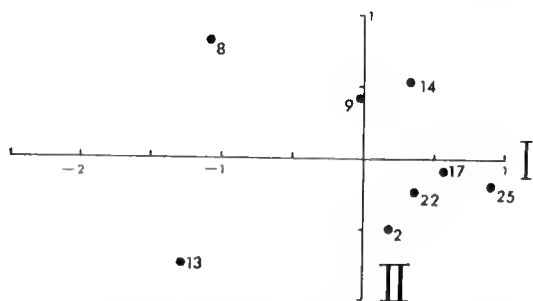
Fig. 21—Canonical analysis of variation in females of *Gymnorhina tibicen*. Point 22 refers to black-backed individuals.

differences between those specimens that were accurately sexed. The Tasmanian (13) population is clearly distinct from all others, even when compared with all male populations and all female populations (Figs. 20-21). That is, the lumping of the sexes has not obscured the distinctiveness. The Tasmanian population consists of smaller individuals.

Geographically near populations exhibit similar morphological variation (Figs. 20-21). Because appropriate comparisons should always be with the nearest population, much variation is not worth naming on the basis of morphological differences. Thus, the SW. Australia (25) point falls closest to the black-backed (22) and white-backed (17) populations in S. Australia, and so on. However, the S. Queensland (2) population falls nearer to the S. Australian (22) population than to the geographically nearer Canberra (8) population. The Canberra population shows a marked divergence from the Victorian (9) population. The Victorian population is almost exclusively made up of white-backed birds whereas the Canberra population consists of about equal numbers of white- and black-backed birds. Possibly character displacement between white- and black-backed birds accounts for the unexpected position of the Canberra point.

Amadon (1962) recognized nine subspecies of *Gymnorhina*. Those in S. and E. parts of Australia were *G. t. dorsalis* (SW. Australia), *G. t. hypoleuca* (Tasmania), *G. t. leuconota* (South Australia and S. Victoria), and *G. t. tibicen* (S. Queensland, New South Wales including Canberra district, N. Victoria and N.

parts of S. Australia). My study suggests that the morphological variation among populations is too complex to explain with these names.

Strepera graculina superspecies and
S. versicolor superspecies

S. graculina and *S. fuliginosa* form a superspecies, the former being found in E. Australia and Lord Howe Is., and the latter being found only on King Is., Flinders Is. and Tasmania. *S. versicolor* and *S. arguta* form another superspecies, with the former being found in SE. and southern Australia and the latter only on Tasmania.
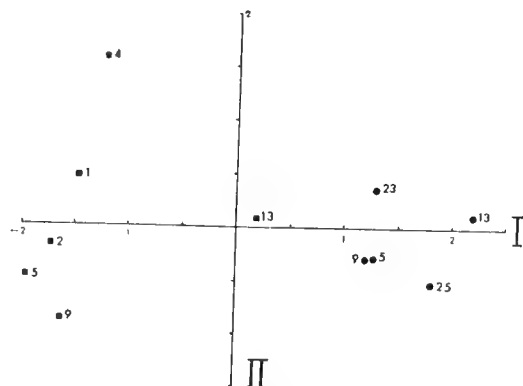

Fig. 22—Canonical analysis of variation in males of *Strepera graculina* superspecies ■ and *S. versicolor* superspecies ●.

S. fuliginosa from Tasmania (13) is clearly intermediate in morphology between *S. graculina* (1, 2, 4, 5 and 9) and *S. versicolor* (5, 9,
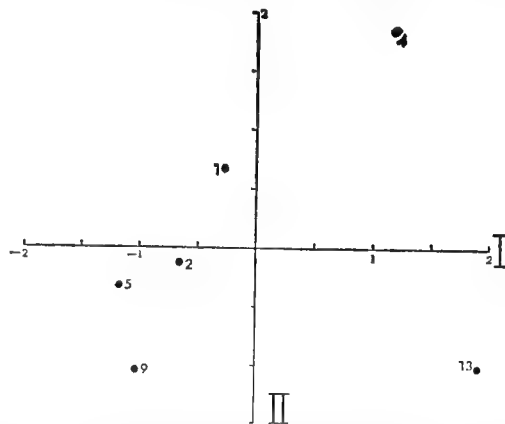

Fig. 23—Canonical analysis of variation in males of *Strepera graculina* superspecies.

13, 23, 25) (Fig. 22). Considering the *S. graculina* superspecies alone (Fig. 23), it is clear that three of the mainland points (Victoria, New South Wales and SE. Queensland 9, 5 and 2) fall near one another. The three isolated populations diverge in different degrees from these. The N. Queensland (1) population is least divergent, and is probably only recently isolated from that of SE. Queensland. The Lord Howe (4) point is as far from the SE. Queensland (2) point as is the Tasmania (13) point from the Victoria point (9), indicating that the distance per se of these islands from the adjacent mainlands is unimportant. These trends hold also for the female populations (Fig. 24). The King Is. (12) point falls near the Tasmanian (13) point.

Clearly, the Tasmanian, King Is., Lord Howe Is. and N. Queensland populations do show a degree of difference in variation that is worthwhile recognizing and naming. This contrasts with Amadon (1962), who recognized four superspecies of *S. graculina*, from Queensland, New South Wales, Victoria and Lord Howe Is. He recognized no subspecies of *S. fuliginosa*, and suggested that *S. fuliginosa* may only be a race of *S. graculina* (see Discussion).

Because of many unsexed specimens and a lack of clearcut differences between those that were sexed, I had to lump sexes for the Victorian and New South Wales populations of *S. versicolor*. The points (9, 5) or these populations fall very close (Figs. 22-25). The
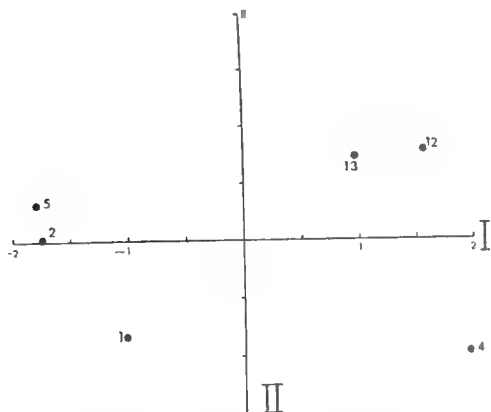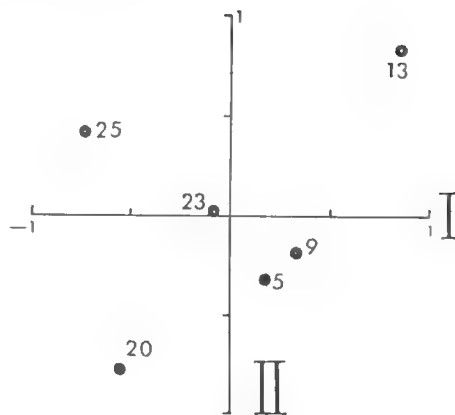

Fig. 25—Canonical analysis of variation in females of *Strepera versicolor* superspecies.

points for the race *S. v. melanoptera* (23) (found in S. Aust. E. of Gulf St Vincent and in W. Vict.), *S. v. intermedia* (20) (found on Eyre and Yorke Peninsulas) and *S. v. plumbea* (25) (of SW. Australia) all diverge from the E. coast points. The Tasmanian (13) population also diverges from the Victorian (9) population (Figs. 22-25).

Amadon (1962) treated *S. arguta* as a subspecies of *S. versicolor*, and recognized six other subspecies. These are from New South Wales-E. Victoria, SW. Australia, NW. Victoria, Kangaroo Is. and S. Australia E. of Gulf St Vincent, S. Australia W. of Gulf St Vincent, and Central Australia. The results for the populations studied here support such divisions.

Conclusions and Discussion

The general aim of any taxonomic study is to discover the relationships that exist among populations, and in particular whether patterns of variation are best described on a subspecific or specific level. An accurate knowledge of which populations are species or subspecies is obviously basic to any subsequent study using lists of species, such as biogeography.

This study indicates clearly how slight transcontinental variation within a species or subspecies compares with variation effected by isolation. All species with representatives on the Tasmanian mainland and/or the Bass Strait islands show differences in morphology from populations on nearby mainland Vic-

Fig. 24—Canonical analysis of variation in females of *Strepera graculina* superspecies.

toria. The problem is whether such differences are worthy of specific recognition (see later).

In all but three cases (*Petroica vittata, Gymnorhina tibicen* and *Acanthorhynchus tenuirostris*) species on the Tasmanian mainland and/or Bass Strait islands show a nett increase in size of the six characters studied. The causes of such shifts are discussed elsewhere (Abbott 1972).

In many cases (e.g. *Gymnorhina tibicen, Eopsaltria australis, Phylidonyris nigra* and *P. novaehollandiae,* and *Melithreptus lunatus*) presently isolated populations in SW. Australia differ in various degrees from their conspecifics in E. Australia. The E. Australian populations are generally much alike in their variation.

It was found that out of the six cases for which I have samples from the Tasmanian mainland, King Is. and Flinders Is., the affinities of the Tasmanian population lie in four cases with the King Is. population, and in two with Flinders Is. This is very surprising, because geomorphological history of the Bass Strait area suggests that populations on Flinders Is. had about 4,000 years more than King Is. during which gene flow with the Tasmanian mainland could have occurred (Abbott 1973). The anomaly can perhaps be explained by assuming that the climate and ecology of King Is. more closely resemble that of the Tasmanian mainland than Flinders Is. This is true for rainfall (Hope 1969). Relevant to this point is that *Acanthiza pusilla, Acanthornis magnus* and *Anthochaera paradoxa* are on King Is. and the Tasmanian mainland but not on Flinders Is.

In general, the range of variation relative to the scale in Figs. 1-25 is much less than that found in other multivariate studies. Reeve's data (1941 and in Seal 1966) show a range of differences between means of each variate of 106-138, 110-140 and 37-51 mm respectively. Hope's data (1969) similarly show large ranges: e.g. her variate BAL ranges from 65 to 80 mm and LP4 from 5·6 to 7·8 mm. Most of the data used in this study show a much smaller range of variation, e.g. bill length for *Malurus cyanus* varied from 8·47 to 10·03 mm and wing length from 50·48 to 55·65 mm.

This being so, it is therefore all the more remarkable that any differences are evident.

There is a curious and largely untested apparent convention implicit in much Australian bird taxonomy. When an isolated population is made up of individuals of a different plumage from individuals in unisolated populations, that population has been deemed to be specifically distinct. As with most things in Australian ornithology, the convention seems to have been started by Gould. He wrote 'On comparing examples from Tasmania with others killed on the continent of Australia, a difference is found to exist in their relative admeasurements, the Tasmanian birds being more robust and larger in every respect; still as not the slightest difference is observable in the markings of their plumage, I consider them to be merely local varieties and not distinct species' (Gould 1865: 574-5).

Examples of such supposed species are *Acanthorhynchus superciliosus* (SW. Aust. representative of *A. tenuirostris*), *Strepera fuliginosa* (Tasm. mainland and Bass Strait islands representative of *S. graculina*), *S. arguta* (Tasm. mainland form of *S. versicolor*), *Malurus splendens* (SW. Aust. representative of *M. cyaneus*), *Sericornis humilis* (Tasm. mainland and Bass Strait islands representative of *S. frontalis*) and *Petroica vittata* (Tasm. mainland and Bass Strait islands form of *P. cucullata*).

However, whenever isolated populations do not differ strikingly in plumage (but usually in measurements of bill or wing), recent taxonomists have also preferred to give such populations mere subspecific status. Examples are *Phylidonyris novaehollandiae* and *P. nigra* in SW. Australia, *Anthochaera chrysoptera* in SW. Australia and Tasmania, *Melithreptus lunatus* in SW. Australia, *Acanthorhynchus tenuirostris* in Tasmania, and *Gymnorhina tibicen* in Tasmania (in Gould's time some of these were even ranked as species).

Taxonomists have not always been consistent, thus giving the impression their criteria for species and subspecies are arbitrary. Thus, *Strepera arguta* on Tasmania has normally been accepted as a full species. Yet the populations of *Strepera* in S. Australia and SW.

Australia have a similar degree of difference from *S. versicolor* of E. Australia, and now they are treated as being only subspecifically distinct by the latest revisor, Amadon (1962). Either *S. arguta* is a subspecies of *S. versicolor* (Amadon's conclusion) or the S. and SW. Australian forms are species (as partly treated by RAOU, 1926). A similar situation could be argued for many of the forms studied in this paper.

Plumage should be as good, or as bad, an indicator of subspecific status as other (e.g. morphometric) differences. Because the only unequivocal test of whether two allopatric populations are different species is whether significant interbreeding takes place after they meet in nature (Mayr 1963), it is not possible to *properly* evaluate the taxonomic status of some of the populations studied in this paper (e.g. *Malurus cyaneus* on the Tasmanian mainland and Bass Strait islands, *Acanthiza pusilla* on Tasmania, *Melithreptus lunatus* in SW. Australia). One celebrated example concerns *Acanthiza ewingi*. If *Acanthiza pusilla* were not present in Tasmania, then *Acanthiza ewingi* being so similar in plumage and morphology (Figs. 4-5) to *A. pusilla* in Victoria would be given subspecific status. The fact that *A. ewingi* and *A. pusilla* come into contact on the Tasmanian mainland and on King Is. without interbreeding surely indicates that they are specifically distinct (Mayr 1942). Similarly, if it were not that *Pardalotus punctatus* and *P. xanthopygus* are sympatric in the Mount Lofty Ranges, and that *Melithreptus lunatus* and *M. albogularis* are sympatric near Brisbane, these species would today be ranked as subspecies, as was done in both cases by Mathews (1930), and in the second case by Rand and Gilliard (1967). Also, White (1790) records, presumably from similarity in plumage and difference in size, that *Anthochaera carunculata* and *A. chrysoptera* are the male and female of one species, and also that *Phylidonyris novae-hollandiae* and *P. nigra* are the sexes of one species. It was not until the 'sexes' were found not to interbreed that it was realized that each 'sex' is a good species.

However, the immediate needs of the bio-logist for the correct name for a population of birds means that the taxonomist has to resort to a less satisfactory criterion. This is best reached when as many characters as possible are considered when making taxonomic judgement.

As rightly pointed out by Oliver (1955), the phrase 'potentially interbreeding natural populations' in Mayr's definition of a species destroys the utility of that definition, because it puts the determination of a form as a species or subspecies back to opinion. This may mean that the modern trend to merge species, though convenient, may not be biologically correct. That is, many forms in SW. Australia and Tasmania, etc., which are at present treated as subspecies may really be species.

The excessive use of subspecific designations has been commented on by many workers (e.g. Serventy 1950, Wilson and Brown 1953). Although it has always been fashionable to deride the work of G. M. Mathews, it is scarcely appreciated that he used concepts that nearly all other workers of his day did (e.g. Ridgway, Bowler Sharp). I think that the enormous collection of skins from all over Australia built up by Mathews enabled him to describe so many new subspecies. Indeed, replying to criticism of his technique, Mathews noted that a large number of his subspecies would even be granted specific rating by some fellow-workers (Mathews 1912). Another reason is that very early workers, such as Latham and Shaw but chiefly Gould, had named many of the populations found at the extremes of species ranges. It remained for the workers in the first few decades of this century, such as Campbell and Mathews, to name the intermediate populations, before the concept of clinical variation had been articulated by Huxley (1942). My study suggests that even many of the trinomials in present use could be dispensed with, because patterns of variation are too complex to be worth naming.

A main aim of my research has been to examine how the results of an intuitive analysis of population variation compare with those from a more objective analysis (my analysis is subjective in the choice of the variables

measured, but more objective in the way that these measurements are analysed). The main objection to an intuitive analysis of taxonomic problems is that it is not consistent, as given a similar degree of variation between populations, they may either be ranked as different subspecies or different species.

Acknowledgements

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Appendix

Sample sizes. The first number of each pair is the locality, the second is the number of specimens measured.

Malurus cyaneus
♂ : 3, 25; 5, 101; 9, 51; 11, 17; 12, 27; 13, 65; 14, 11; 16, 13; 17, 25; 18, 13; 19, 8. Total: 356 specimens.

Malurus splendens
♂ : 25, 52. Total: 52 specimens.

Sericornis frontalis superspecies
♂ : 3, 14; 5, 36; 9, 31; 11, 17; 12, 20; 13, 39; 17, 9; 18, 10; 25, 50; 26, 11. Total: 237 specimens.
♀ : 3, 9; 5, 22; 9, 16; 11, 12; 12, 7; 13, 13; 17, 10; 25, 47; 26, 11. Total: 147 specimens.
♂ + ♀ : 10, 10. Total: 10 specimens.

Acanthornis magnus
♂ + ♀ : 13, 17. Total: 17 specimens.

Acanthiza pusilla superspecies
♂ : 3, 10; 5, 19; 6, 14; 9, 28; 13, 28; 14, 19; 17, 12; 18, 10; 19, 9; 25, 46. Total: 195 specimens.
♀ : 3, 5; 5, 8; 6, 14; 9, 6; 13, 17; 17, 5; 18, 5; 25, 22. Total: 82 specimens.
♂ + ♀ : 21, 10. Total: 10 specimens.

Acanthiza ewingi
♂ : 11, 9; 12, 13; 13, 32. Total: 54 specimens.
♀ : 11, 6; 12, 7; 13, 12. Total: 25 specimens.

Acanthorhynchus tenuirostris superspecies
♂ : 3, 9; 5, 22; 7, 22; 9, 19; 13, 24; 17, 7; 25, 55. Total: 158 specimens.
♀ : 5, 25; 7, 25; 9, 10; 13, 20; 17, 5; 25, 16. Total: 101 specimens.

Melithreptus lunatus superspecies
♂ : 3, 21; 5, 21; 9, 24; 13, 41; 17, 9; 25, 52. Total: 168 specimens.
♀ : 3, 15; 5, 15; 9, 7; 13, 23; 25, 33. Total: 93 specimens.

Melithreptus gularis superspecies
♂ : 3, 5; 9, 6; 12, 7; 13, 21. Total: 39 specimens.

Meliphaga leucotis superspecies
♂ : 3, 9; 5, 26; 6, 27; 9, 29; 11, 7; 12, 9; 13, 47; 15, 13; 18, 8; 19, 7; 25, 11. Total: 193 specimens.
♀ : 3, 5; 5, 21; 6, 19; 9, 15; 12, 6; 13, 38; 15, 9; 19, 6; 25, 6. Total: 125 specimens.

Phylidonyris novaehollandiae
♂ : 5, 31; 7, 25; 9, 23; 11, 6; 12, 18; 13, 43; 17, 14; 25, 41. Total: 201 specimens.
♀ : 5, 19; 7, 25; 9, 20; 12, 7; 13, 21; 17, 8; 25, 27. Total: 127 specimens.
♂ + ♀ : 3, 6. Total: 6 specimens.

Philidonyris nigra
♂ : 3, 26; 5, 36; 25, 16. Total: 78 specimens.
♀ : 3, 5; 5, 19; 25, 8. Total: 32 specimens.

Anthochaera carunculata superspecies
♂ : 3, 11; 5, 19; 9, 24; 12, 5; 13, 39; 17, 8; 25, 24. Total: 130 specimens.
♀ : 5, 20; 9, 13; 13, 23; 17, 11; 25, 18. Total: 85 specimens.

Anthochaera chrysoptera
♂ : 3, 7; 5, 16; 9, 5; 13, 22; 25, 15. Total: 65 specimens.
♀ : 3, 5; 5, 16; 9, 8; 13, 18; 14, 7; 25, 18. Total: 72 specimens.

Petroica cucullata superspecies
♂ : 2, 14; 5, 36; 9, 15; 11, 7; 12, 16; 13, 28; 22, 21; 25, 15. Total: 152 specimens.
♀ : 5, 21; 11, 7; 12, 13; 13, 16; 21, 5; 22, 11; 25, 11. Total: 84 specimens.

Eopsaltria australis
♂ : 1, 13; 2, 41; 5, 49; 9, 38; 19, 10; 25, 57. Total: 208 specimens.
♀ : 1, 13; 2, 14; 5, 29; 9, 8; 14, 7; 19, 5; 25, 31. Total: 107 specimens.

Eopsaltria georgiana
♂ : 25, 23. Total: 23 specimens.
♀ : 25, 15. Total: 15 specimens.

Gymnorhina tibicen
♂ : 2, 16; 8, 22; 9, 22; 14, 9; 17, 16; 22, 12; 25, 22. Total: 119 specimens.
♀ : 2, 16; 8, 22; 9, 15; 14, 6; 17, 20; 22, 7; 25, 29. Total: 115 specimens.
♂ + ♀ : 13, 29. Total: 29 specimens.

Strepera graculina superspecies
♂ : 1, 7; 2, 13; 4, 7; 5, 24; 9, 11; 13, 17. Total: 79 specimens.
♀ : 1, 8; 2, 9; 4, 7; 5, 5; 12, 6; 13, 10. Total: 45 specimens.

Strepera versicolor superspecies
♂ : 13, 11; 23, 16; 25, 27. Total: 54 specimens.
♀ : 13, 11; 20, 7; 23, 15; 25, 27. Total: 60 specimens.
♂ + ♀ : 5, 25; 9, 22. Total: 47 specimens.

Memoir 34 Errata

Page 196 Interchange captions of Figs. 1 and 2.

199 Col. 2. Read "112 km S. of W. of No. 13."

205 Col. 1, line 18. Read "degrees".
Col. 2, line 22. Read "flanged".

207 E, D and C belong to Fig. 2. Under AC read "30 mm" (not m).

231 Interchange captions of Pl. 31.

277 Col. 1, line 1. Read "*Pseudonaja*".

278 Col. 1. Replace last line with "of the Murray River, and many".